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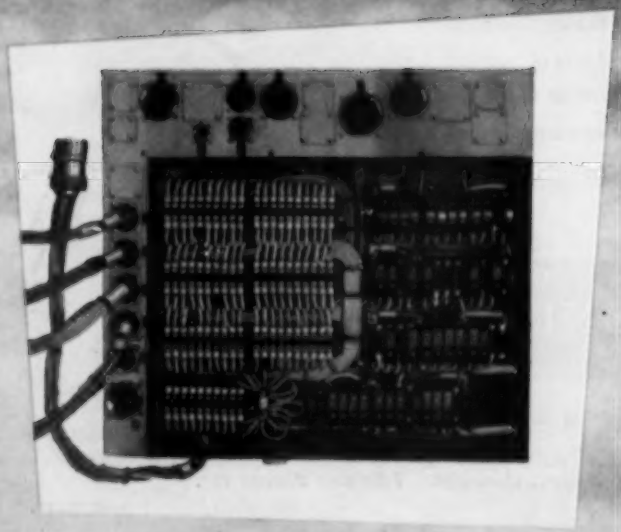

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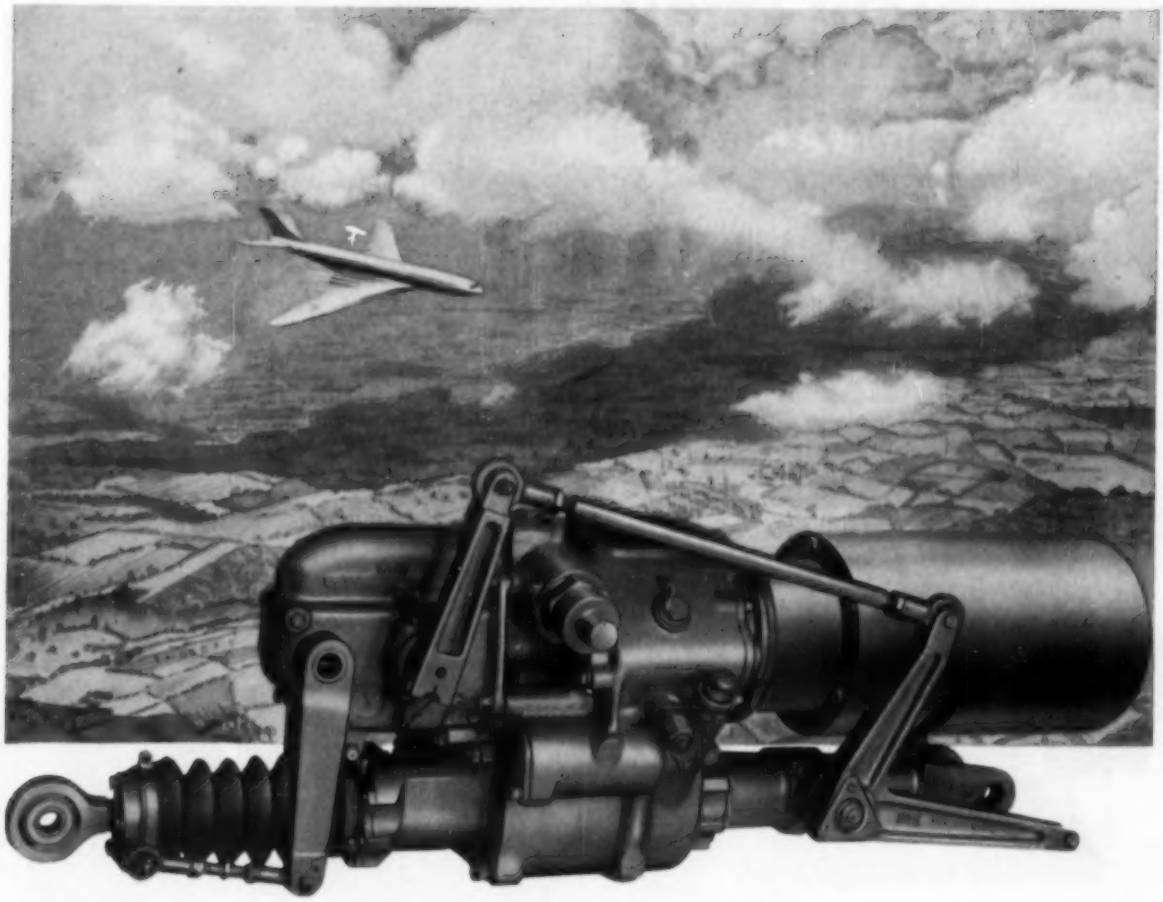

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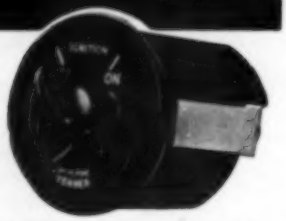

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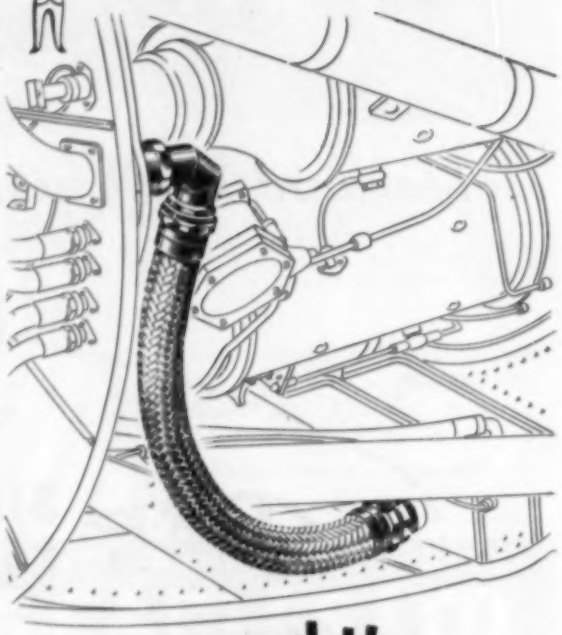

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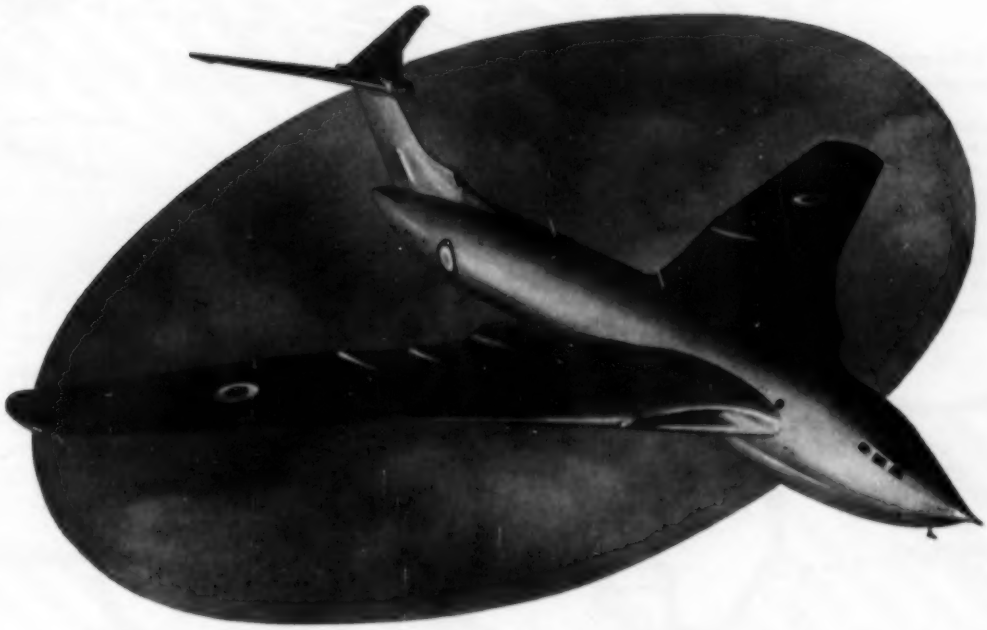

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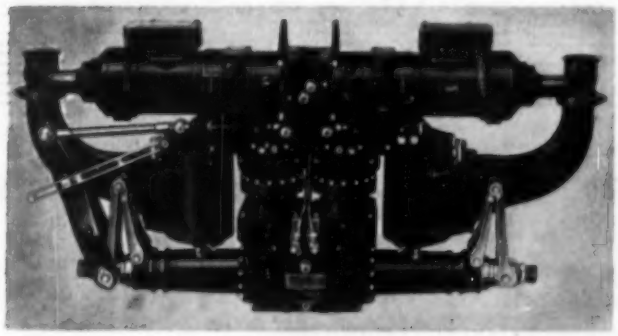

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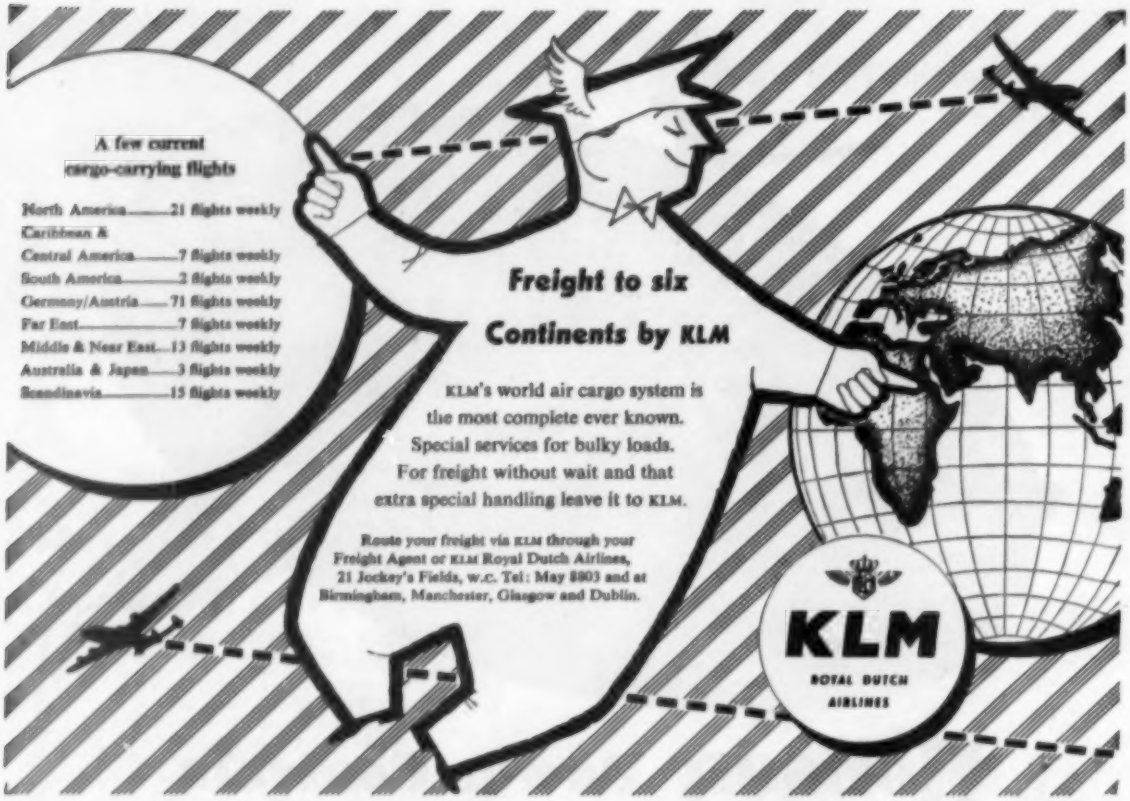
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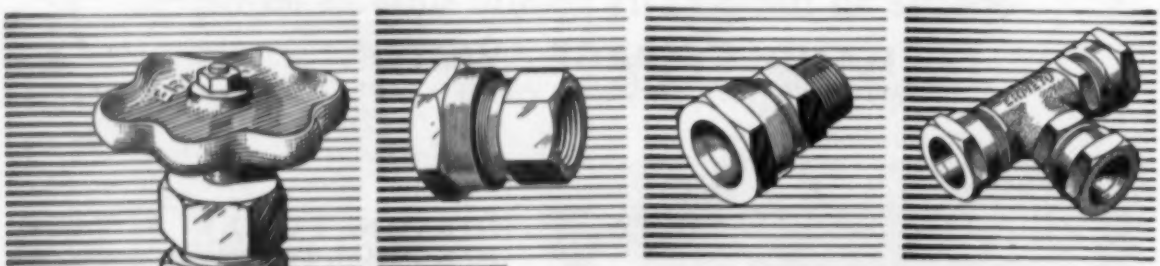

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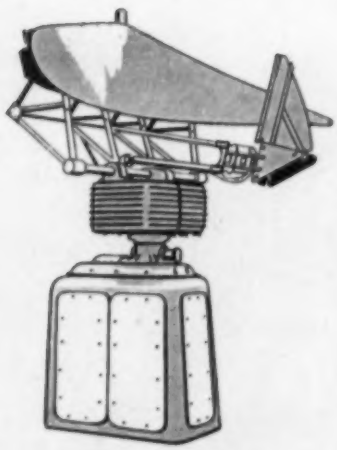

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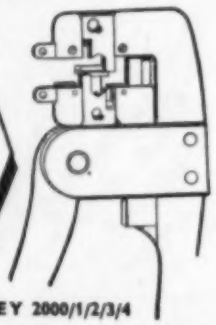

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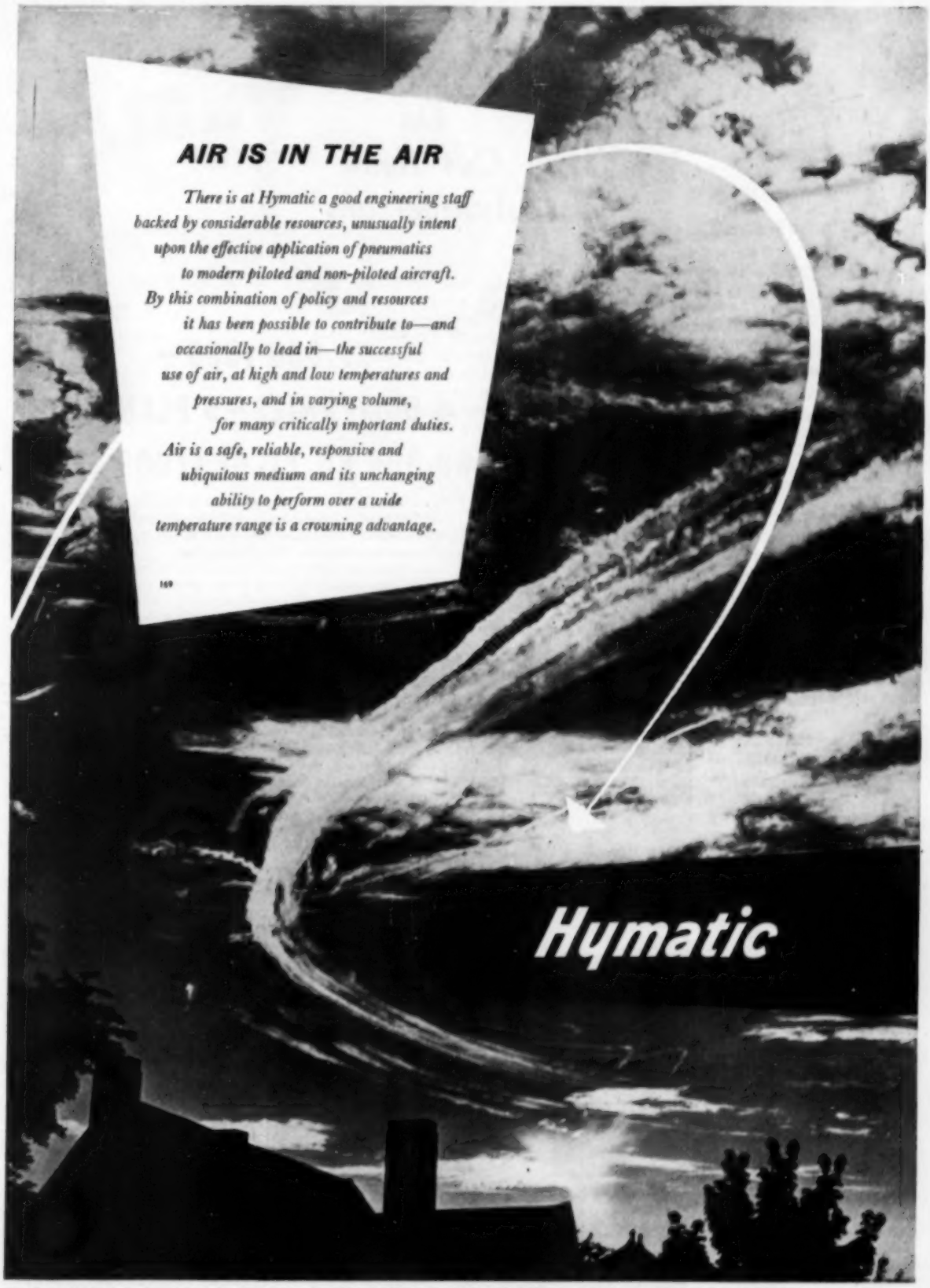
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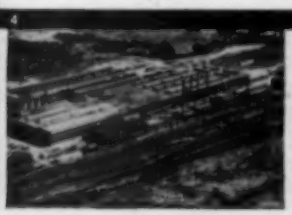

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FLIGHT
and
AIRCRAFT ENGINEER

No 2445 Vol 68 FRIDAY 2 DECEMBER 1955

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The Big Boats

FROM the splendid old Felixstowe flying-boats (their story is told in this issue) stemmed a succession of machines which gave this country an acknowledged lead in the development of marine aircraft; and with the introduction of the Short "C" class boats on the Australia run—likewise commemorated this week—the big commercial boat attained its apotheosis.

The significance of that event paralleled in its day the recent phenomenal acceptance of the pure-jet airliner, for the "C" boats set wholly new standards of comfort, safety and speed. Never had such excellent machines been built in such numbers and with such clarity of purpose, and never since has an undertaking of like proportions been carried through with such complete success.

To the descendants of these boats the future of Empire commerce seemed largely committed; but it was not to be. The landplane triumphed inexorably, and five years have now gone by since flying-boats bore the Speedbird over the Empire routes. There remain on the British register only the five Solents of Aquila Airways, while in R.A.F. service a few dogged Sunderlands work out their days to the undiminished honour of the name of Short. At Calshot and Cowes the three beautiful Princesses sleep on embalmed until a nameless god of Bristol shall break the spell—a romantic happy ending which may never, alas, come about.

An American journal has done this country the honour of implying that something momentous is afoot here in respect of flying-boat construction. Would that we knew it to be true. The sad fact is that, while the SeaMaster and Tradewind further the flying-boat tradition in the New World, the purse strings of the Treasury continue to throttle prospective British developments. Undaunted, the faithful ones at Cowes pursue their tank-testing of hydro-skids, hydro-skis and planing plates, and of hull forms so advanced that, should the word at length be given, an entirely new class of British flying-boat could with little delay be shaping on the stocks.

Legal Liabilities

IMPORTANT questions of the liability of aircraft owners for accidents to people on the ground were posed, but left unanswered, during a recent High Court action (reported on page 825). A woman unsuccessfully claimed damages against the pilot and the owner of a light aircraft which, it was alleged, had flown low and so caused her to be thrown from a horse and injured.

One point which arose, and which is of urgent significance to all aircraft owners, is that contained in Section 40(2) of the Civil Aviation Act of 1949. This states that, "where material loss or damage is caused to any person on land or water by . . . an aircraft while in flight, taking off or landing, then [unless there is contributory negligence by that person] damages . . . shall be recoverable *without proof of negligence or intention or other cause of action, as if the loss or damage had been caused by the wilful act, neglect or default of the owner of the aircraft.*"

In the High Court case, the owner's counsel urged that, on a true interpretation, the owner possessed this liability only in cases where the pilot was his servant or agent. Certainly the literal reading of the above sub-section is unfortunate; and in cases of unauthorized pilotage it is obviously unfair. A relevant analogy is the common-law liability of owners of ships and land vehicles, which is based not upon mere ownership but upon the negligence of persons for whose conduct the owner is responsible.

Another significant question is whether a technical breach of regulations unconnected with the alleged nuisance can invalidate the owner's exemption from liability contained in Section 40(1), one requirement of which is that the flight be carried out in compliance with the law. Other anomalies in common-law and statutory actions connected with flying may be recalled. It is regrettable that an owner's liability may still depend on the results of a barrister's rhetoric and the choice of witnesses rather than on a clear and logical ruling. There is indeed little excuse for legislation which remains static and vaguely intentioned.

DASSAULT DELTA: Bearing a remarkable resemblance to Britain's Fairey F.D.2 is the Marcel Dassault M.D.550 "Mystère Delta" intercepter, seen in this first flight view. The power units are at present two Dassault M.D.30s (licence-built Armstrong Siddeley Vipers, without reheat), but a SEPR liquid-fuel rocket will eventually be added.

FROM ALL QUARTERS

Royal Tour of Nigeria

THE Colonial Office announced this week that on their tour of Nigeria in the New Year the Queen and the Duke of Edinburgh will travel mainly by air. They will leave London in a B.O.A.C. Argonaut on January 27th and fly direct to Lagos. Thereafter, aircraft of the Queen's Flight will be used. On February 1st the royal visitors will fly to Kaduna for a State dinner; on the 3rd they will go by air to Jos, on the Bauchi Plateau, for the week-end; and on the 6th they will fly to Makurdi, then on to Enugu. They will return by air to Lagos on the 9th, and their return flight to London, with a brief stop at Kano, will begin on February 16th.

Forty Tons on Skis

TWO Lockheed P2V Neptunes fitted with skis have completed tests at Thule, Greenland, in preparation for the forthcoming U.S. expedition to the Antarctic. The aircraft form part of Squadron VX-6, whose mission, in addition to survey and the support of surface parties, will be the air delivery of materials for the construction of a base at the South Pole. The Neptunes, which at 40 tons gross are probably the heaviest aircraft ever fitted with skis, will have rocket-assisted take-off gear. They are due to leave Christchurch, New Zealand, for McMurdo Sound on December 15th.

Bon Voyage, Comet 3

AT dawn this morning, December 2nd, the Comet 3 prototype was due to leave the de Havilland airfield at Hatfield on the first stage of a three-week world proving flight as part of the development programme for the Comet 4. The aircraft is flying first to Sydney, Australia, *via* Cairo, Bombay, Singapore and Darwin. Normal jet airliner operational procedures will be followed throughout the tour, and B.O.A.C. are providing servicing facilities along the route and a senior captain to accompany the flight crew.

Although record-breaking is incidental to the main purpose of the flight, which is to assess performance under realistic world airline conditions, it is of interest that, circumstances permitting, the Comet 3 is capable of traversing the 11,400-mile route to Sydney within 30 hours, about half the present airline scheduled time. (Appropriately, the official London-Sydney record still stands at the 80 hr 56 min, set up in 1938 by Clouston in a D.H.88 Comet.) The fastest flight ever from England to Australia was by an English Electric Canberra (F/L. L. M. Whittington) in January 1953: elapsed time London to Darwin —1,965 miles short of Sydney—was 22 hr 8 min.

Decision as to which route the Comet will follow on its return flight will be made in Sydney; it is possible that, after flights in Australia, it will return *via* the Pacific Ocean, Canada and the North Atlantic.

The opportunity will be taken during the proving flight to demonstrate the aircraft to airline executives in Australia and elsewhere. The Comet will be flown by John Cunningham, de Havilland chief test pilot, with a crew of 14 observers and technicians.

Germany's Industry Pessimistic

AT a meeting of the Association of West German Aircraft Constructors in Düsseldorf on November 25th, Dr. Rothe, president of the Association, indicated that unless the German Government made up its mind soon about the financing of a new West German aviation industry, it would be too late. The new Luftwaffe, he said, had certain time schedules to fulfil for the formation of its squadrons. If preparations for equipping them partly with aircraft built under licence in Germany were delayed much longer, the Luftwaffe would become dependent solely on aircraft bought from abroad.

Another speaker at the meeting was 70-year-old Dr. Claudius Dornier who expressed the view that it would be three years before West Germany could build modern military jet aircraft, even under licence. Six Do 27 communications aircraft would be built in his own works at Munich next summer. They are believed to have been ordered by the Defence Ministry.

Other news that emerged from the meeting was that West German aircraft builders had, with two exceptions—Dornier and Focke-Wulf—formed themselves into two manufacturing combines. These were Blohm and Voss, Henschel, Siebel, and the Krupp-controlled Weser company in northern Germany; and the Heinkel and Messerschmitt groups in the south. These combines intended to share only production orders for airframes built under licence; development of new types could be undertaken individually.

So far (writes a correspondent in Germany) the West German Government has not shown much sign that it favours the financial outlay necessary for the rebuilding of the aviation industry. Prof. Kurt Tank recently told the Press that in the foreseeable future the chances of producing modern high-performance aircraft in the Federal Republic were nil.

The V.1000 : Supply Minister Questioned

CONSIDERABLE misgivings about the decision to cease development of the Vickers-Armstrongs V.1000 were expressed in the House of Commons on Monday when the Minister of Supply, Mr. Reginald Maudling, was questioned by M.P.s on the reasons for that decision.

Mr. Maudling said it had taken longer than was hoped to overcome some of the problems and to meet specifications laid down for the V.1000. In view of the urgency of re-equipping Transport Command, it had been decided to take the long-range Britannia, which had been developing well and which could be made available earlier. In these circumstances, contracts for one prototype and six production aircraft had been cancelled. Mr. Maudling added that it had been decided not to provide public funds for the development of the civil version of the V.1000, since B.O.A.C. had no requirement for it.

MR. PAUL WILLIAMS (Con., Sunderland South) remarked that free-enterprise America had found it necessary to subsidize civil air development. Would the Minister not agree, he asked, that unless this country could also find some suitable method of assisting civil aircraft develop-

FOR THE 55th PARALLEL: A Sikorsky H-34 (that being the U.S. Army designation of the Sikorsky S-58) has become a recent addition to the R.C.A.F.'s expanding fleet of helicopters. Six are scheduled to be delivered for transport duties connected with the mid-Canada radar chain along the 55th parallel.

ment, it might well be that there would be no first-class transatlantic British transport aircraft operating in the late 'sixties or early 'seventies?

MR. MAUDLING replied that the Government had done a great deal to help civil aircraft production but it could not help where there was no aircraft operator willing to operate an aircraft.

MR. JOHN RANKIN (Lab. and Co-op, Glasgow, Govan) recalled that when the Brabazon was scrapped the manufacturers defended the amount of money that had been spent on it on the grounds that it had provided them with all the knowledge associated with the building of heavy aircraft of this nature in the future. How did this fit in with the decision to scrap the V.1000?

MR. MAUDLING replied that a great deal of the work in the Brabazon had gone into the development of the Britannia.

MR. G. A. BROWN (Lab., Belper) asked if it was not rather unfair to take this decision because of the alleged delays, when in fact it could have been completed by the original flying date. He went on to claim that the Government's decision would allow Douglas and Boeing to get so far ahead that it would take us 10 to 20 years to catch up with them.

In refuting a further charge by Mr. Brown that the real truth was that the Minister was told to economize on his department's expenditure, Mr. Maudling said he did not accept the questioner's gloomy view about the future prospects in jet transport. Nor could he accept the point about dates of the V.1000. The fact was that the original date was well before 1960 and could not be met.

A. CDRE. A. V. HARVEY (Con., Macclesfield) observed that since the Minister had made his original statement about the V.1000, Royal Dutch Airlines had ordered a great number of DC-8s, and this aircraft would be sold all over the world. There was great disquiet in many circles in Britain about this matter, he said, particularly taking into account what Mr. George Edwards had said.

MR. MAUDLING retorted he did not accept that the decision left Britain far behind in this respect. Again he suggested that aircraft of this category could not be launched into the markets of the world unless a home purchaser could be found to operate them.

MR. JOHN STRACHEY (Lab., Dundee West)—who was a War Minister in the Labour Government—said from a military point of view it was a very serious decision to abandon all attempts in the field of straight jet transport aircraft for the movement of military personnel. Would the Minister not reconsider the question of developing something, even if it was not the V.1000?

MR. MAUDLING reminded him that R.A.F. Transport Command would be operating the Comet pure jet transport.

The Minister later replied to a long question in which MR. ROBSON BROWN (Con., Esher) asked whether he would review his decision in view of the new V.1000 performance figures just released by the manufacturers, since these revealed that the civil version of this aircraft was potentially superior to any projected United States long-range jet transport, in that it had more power, shorter take-off, better operating economy, and was designed round the most suitable type of engine for this work yet produced.

MR. MAUDLING repeated his refusal as contained in his statement to the main exchange of questions. In doing so he commented: "There is always room for differing views about the eventual performance of an aircraft which has not yet flown."

Long-term Test Pilot

FEW test pilots anywhere can have equalled the total of over 7,000 hours of flying for one firm. Such is the record of Ronald Ellison, who has just retired from test flying for the Bristol Aeroplane Co. and taken up an appointment with the company's sales department. His Bristol experience goes back 21½ years, embracing at least 36 different types of aircraft and development flying on nine engines—Pegasus, Mercury, Perseus, Aquila, Taurus, Hercules, Centaurus, Theseus and Proteus. He was the first man to take the Proteus into the air (in a Lincoln test-bed) and has flown in all some 8,000 hours, on 80 different types of aircraft.

Mr. Ellison

Born in 1908 and educated at Bedford School and in H.M.S. *Conway*, Mr. Ellison spent three years in the Merchant Service before taking a short-service commission in the R.A.F. in April 1929. In 1930 he was posted to No. 17 (Fighter) Sqn. at Upavon, where he flew his first Bristol aircraft, the Bulldog. After a course at the C.F.S., he was posted as an instructor at Cranwell. During the last year of service he flew Wallaces and Wapitis with No. 501 Reserve Squadron at Filton, where he became well known to staff of the Bristol Flying School. As a result, he was offered a post as instructor when, with some 1,000 hours in his log, he left the R.A.F. in 1934.

In addition to acting as instructor at the school (then equipped with Tiger Moths), Mr. Ellison was employed on the development flight testing of a variety of Bristol engines. When war broke out, he joined the test pilot staff and on January 1st, 1941, became chief production test pilot at the Company's Weston-Super-Mare shadow factory. Of the total of over 3,300 Beaufighters built at Weston during the next five years, he flew precisely 1,800, including the 1,000th, 2,000th, 3,000th and last aircraft. In 1945 he returned to Filton, where he was engaged on the flight testing of the Buckingham, Buckmaster, Brigand and Freighter and the development testing of Hercules, Centaurus, Theseus and Proteus engines. In 1949, he was made assistant chief test pilot, a position which he relinquished at the end of 1952.

Since the war, Ronald Ellison has flown many thousands of miles as the pilot of Bristol Freighters. While demonstrating the aeroplane or instructing new pilots, he visited Pakistan (three times), Brazil, Argentina, Canada, Australia, New Zealand, Burma and Iraq. Early this year he flew to Johannesburg a Freighter loaded with supplies and equipment for the Britannia's tropical trials. He made the flight of over 6,000 miles with four night stops in a total flying time of 43 hr.

***BANGALORE TRAINERS:** Now engaged on a tour of Burma, Thailand, Cambodia, Malaya and Singapore is a Hindustan Aircraft HT-2 trainer of the type illustrated. Built in the Bangalore district of India, the HT-2 has a Blackburn Cirrus Major Series 3 engine of 155 h.p., and is designed for unrestricted aerobatics at a gross weight of 2,240 lb.*

Low-flying Damages Claim Fails

A CLAIM for damages made by Mrs. Evelyn Greenfield, of Skegness, against the pilot and owner of an Auster aircraft which, she alleged, flew low and caused the horse she was riding at Skegness on Christmas Day, 1952, to bolt and throw her, was dismissed by Mr. Justice Gorman in the Queen's Bench Division last week. The judge stated that, on the evidence presented, he did not find that the accident was caused by the aircraft.

Mrs. Greenfield, who said that the Auster had swooped low over her head, had alleged that the pilot, Mr. Harry Law, of Peterborough, had created a nuisance and was guilty of negligence. She also claimed damages from the owner of the machine, Mr. L. G. Wright, of Caistor-on-Sea, under Section 40, subsection 2 of the Civil Aviation Act, 1949.

Mr. Law stated in evidence that he was returning to Skegness Aerodrome because of a rough-running engine shortly after taking off, and passed over the road where the accident occurred at more than 300ft. Mr. Wright said that Mr. Law did not have his permission to fly the aircraft at any time.

Giving judgment, Mr. Justice Gorman reviewed the various points of law involved, but came to no conclusion on them. He said that he could not accept the allegations of the plaintiff as to the manner in which the aircraft was flown, and he found that they were unfounded in fact, whether or not they would have amounted in law to nuisance or negligence.

A leading article on a particular issue raised by this case appears on page 823.

Met. Office Progress

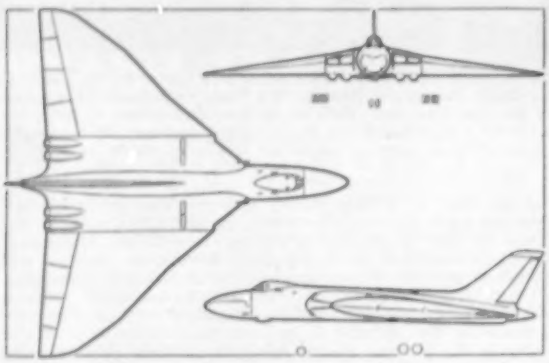
DEVELOPMENT of a short-range weather forecasting method using an electronic computor is reported in the Annual Report of the Meteorological Office for the year ending March 31st, 1955. This method, devised by the Forecasting Research Division in the Napier Shaw laboratory at the Central Forecasting Office, Dunstable, was stated to give results comparable in accuracy to those obtained by traditional methods. Other activities of this Division in the field of short-range forecasting included the analysis of upper-air observations by numerical methods (in preparation for electronic forecasting without intermediate plotting and visual interpolation); a study of statistical methods of forecasting high-level winds; and statistical synoptic investigations on rainfall distribution from fronts, the movement of depressions, and the degree of persistence of strato-cumulus.

The services provided by the Meteorological Office for the R.A.F. and for civil aviation are described in detail in the report. Concerning special work for civil aviation, this has included the provision of turbulence reports for the U.S. Weather Bureau in

FROM ALL QUARTERS . . .

connection with the I.C.A.O. investigation of clear-air turbulence. Local meteorological offices at London and Prestwick co-operated with airlines in special load-planning trials, and with the selection of least-time tracks on North Atlantic routes. The Meteorological Research Flight, Farnborough, has continued to investigate the properties of the stratosphere, in particular its water content, leading towards an understanding of the general circulation of the atmosphere.

The report is obtainable from Her Majesty's Stationery Office, price 2s 6d.



VULCAN ROUND-UP: Contrary to the impression conveyed by the photograph in "Flight" of November 4th (p. 704), the wing-tips of the Avro Vulcan as revised for production are rounded, and not square-cut. We are assured that the angular appearance suggested by the photograph was an optical illusion; the true form is apparent in this new three-view drawing.

INSTEPS: Built-in passenger steps—seen above in a Vickers test rig—are to be fitted to the majority of the Viscounts on order for Capitol Airlines. Hydraulically operated, they will be offered as standard on aircraft for the American market. Installation is in the forward door and the weight penalty is in the region of 260 lb.

"The Dam Busters" Honoured

AT a gathering of the Air Public Relations Association at the Martinez Restaurant, Piccadilly, on November 23rd, Mr. Michael Anderson, director of *The Dam Busters*, was presented with the C. P. Robertson Memorial Trophy "for interpretation of the Royal Air Force to the public." Lord Willoughby de Broke made the presentation.

The trophy, awarded annually (last year it went to Dennis Richards and Hilary St. George Saunders for their History of the R.A.F.), was accepted on behalf of Mr. Anderson, who was in Hollywood, by Mr. Robert Clark, production director of Associated British Picture Corporation. Runner-up for the award was the B.B.C. Television series *War in the Air*.

A FAIREY "FORTY YEARS" A.G.M.

THAT the most recent Fairey guided missile had achieved a "spectacular success" and was now going into initial production was revealed by Sir Richard Fairey, chairman of the Fairey Aviation, Co., Ltd., in his address to shareholders at the annual general meeting on November 24th. Sir Richard said that he was unable to give any further particulars. He went on to say that the company had succeeded in obtaining from the Atomic Energy Authority "considerable orders for various appliances."

Sir Richard had opened his report by announcing that the consolidated group trading profit for the year, before providing for taxation, was £2,159,568 as compared with last year's profit of £1,249,216; this was, of course, a gross profit, of which taxation would take over 62 per cent, and it was also a group profit, contributed by the overseas companies and other subsidiaries such as the Air Survey Co.; but, added Sir Richard, "This is our record profit and we have no apologies to offer on that account, least of all to the political theorists who declaim against all profits as such. On the contrary, I here and now declare our intention of using our utmost efforts to continue to make profits."

Pointing out that this was the company's 40th anniversary year, the chairman went on to recall that the original capital was £22,750, of which only £15,000 was ever paid up in cash. The first factory, consisting of five wooden sheds on the site where the Hayes plant now stands, cost £807 6s 8d, and the first offices, a brick building which was still standing, cost £1,013 18s 5d. "Our profit for that year," added Sir Richard, "was £7,114 11s—not a bad start."

He continued: "During the past 40 years we have designed and built 109 different marks of aircraft, of which 48 were distinct types ranging from small single-seaters to four-engined flying-boats. By your seats you will find a reprint from the magazine *Flight* giving some interesting particulars of these. Many of our aircraft, such as the famous Swordfish, have rendered yeoman service to the country and others have produced large sums from export trade; yet others have broken world records for performance. I think that we can claim that the remarkable Fairey Fox of 1925 altered the whole trend of design of military aircraft. We have pioneered not only aircraft but, for example, such things as variable-pitch propellers, stressed-skin structures, and the first free coupled twin engine.

"And we are still pioneering today in guided weapons, hydraulic control apparatus, precision casting and the specialized application of plastics and other new production methods—among which our patent envelope jigging system is a marked success. Today we are developing the largest helicopter and the smallest helicopter and what we believe to be the country's fastest aeroplane."

Sir Richard said that the company had spent very large sums in the development of private-venture aircraft, and any recovery of the money was dependent upon their success. An example was the Gannet, to which the company's contribution had been £539,500, now in process of repayment from production. Large contributions had also been made towards aircraft not destined for future quantity production, the money being invested purely in experience. Their first helicopter cost them £338,000 and the Delta 1 £382,000.

Other points from Sir Richard Fairey's long and detailed statement included the news that the Ministry of Supply had cut back Gannet rate of delivery. They had not cancelled any orders, but the consequence of slowing the production rate was that the company would not get further orders for this type as soon as was hoped.

Discussing the maintenance of production capacity, Sir Richard expressed the view that the industry should be entrusted with the repair and maintenance of the aircraft which it produced: "For one thing I am bold enough to believe that we can do this work more cheaply and efficiently. Moreover, without the opportunity of observing at first hand which parts go wrong or wear out first, we are handicapped in improving our aircraft in regard to maintenance and ease of repair. Thus to the extent to which this work is done by Government depots the industry is deprived of valuable turnover and experience."

On the subject of production orders in relation to political policy, Sir Richard said that the difficulties of the Ministry of Supply in this respect were understandable; but the shifting conditions presented the aircraft industry, also, with some severe problems. "For example," he said, "in the case of the Gannet we were 18 months later than the builders of other super-priority aircraft in getting our order, with the result that other manufacturers got in first with the suppliers of such important items as forgings and absorbed the best sub-contractors. We were pressed urgently to put our very best efforts into early production and on a very considerable scale. We did just that, and to such effect that we recovered for the Service the lost 18 months: the Gannet was the first of the super-priority aircraft to go into squadron use and the production was advancing, to plan, towards the high figure required. Before that was reached the cut-back started and our efforts and expenditure on tooling were partly wasted."

The A.G.M. was followed by an extraordinary general meeting, at which approval was given to the Board's proposal to increase capital from £1¼m to £2½m.

GOODWILL from ITALY

Italian C.A.S. Visits the R.A.F.

Gen. Raffaelli inspects the guard of honour at the Central Fighter Establishment, West Raynham, where he watched a flying display. **"Flight" photograph**

A REMINDER of the common aims of the Royal Air Force and the air forces of its NATO allies was occasioned by the official visit to the R.A.F. last week of General Ferdinando Raffaelli, Chief of Staff of the Italian Air Force. The general, who was the guest of the Chief of the Air Staff, Marshal of the Royal Air Force Sir William Dickson, was accompanied by his senior staff officers, Col. G. Valentini, whose responsibilities include the tactical and operational organization of the Italian Air Force, and Col. G. Callieri, chief of the technical equipment and logistics branch. The party included Gen. Raffaelli's aide, Maj. A. Quattrocchi, Col. G. Pelosi, Italian air attaché, and S/L. J. F. Sach, D.F.C., A.F.C., representing the Chief of the Air Staff.

Gen. Raffaelli, now in his 57th year, was appointed Chief of Staff of the Italian Air Force a year ago. After serving as an Army engineer, he qualified as a pilot in 1927, subsequently commanding a bomber wing. Still an active pilot, now with some 3,000 hours, he was in 1946 one of the first Italians to convert to jet fighters.

The general arrives at the Air Ministry on the first day of his visit, November 21st, with Sir William Dickson, Chief of the Air Staff.

Since the Italian Air Force today puts most emphasis on fighter operations, and because the geographical problems of Italy's air defence are not unlike those of Great Britain, it was appropriate that Gen. Raffaelli's four-day tour should have begun with a visit to Fighter Command H.Q. at Bentley Priory, Stanmore. After being shown the R.A.F.'s day and night fighter control system, the general had an hour's talk—the first of several—with Sir William Dickson, and with Air Marshal Sir Dermot Boyle, A.O.C-in-C. Fighter Command. Later in the day the general had private talks with Mr. Selwyn Lloyd, Minister of Defence, and with Mr. George Ward, Under-Secretary of State for Air. At the Dorchester Hotel in the evening the general and his wife were guests of honour at an Air Council dinner.

On the following day Transport Command's elegant V.I.P. Hastings took Gen. Raffaelli from Northolt to Manby, where he saw some of the activities of the R.A.F. Flying College. A ninety-minute tour included inspection of the new specialist courses on guided weapons, and of the College's comprehensive variety of training aids.

The highlight of Gen. Raffaelli's visit was the flying display at West Raynham, home of the R.A.F. Central Fighter Establishment. After taking the salute and inspecting his guard of honour, Gen. Raffaelli watched from the control tower with A.V-M. W. J. Crisham, A.O.C. No. 12 Group; A. Cdre. P. H. Dunn, A.D.C. to the Queen; and G/C. J. M. Thompson, who is acting commandant of C.F.E. while A. Cdre. Grandy is in Australia.

In spite of dispiriting weather—low autumnal mist lying over the whole of Norfolk—and the premature retirement of No. 43 Squadron's aerobatic team, owing to an obstinate nosewheel door on the leading Hunter F.4 (F/L. P. Barstow), C.F.E. put up a worthy show. The overture was a crackling take-off by six Hunters of the Day Fighter Leader School, curtain-raiser to a sedate fly-past by a Valiant—an alien to the fighter preserves of West Raynham—flown by S/L. Richley from R.A.F. Wyton.

Also from the bomber camp, although actually on the strength of C.F.E., was the Canberra B.6 (F/L. W. Hesketh) which followed, giving a Beamont-type exposition of the Canberra's agility. Next, Lt-Cdr. R. Knight, R.N., made full use of his Venom N.F.3's powered ailerons in very fast rolling passes. A yellow Sycamore competently justified its RESCUE annotation by hoisting a stranded airman to safety from the exposures of West Raynham airfield. The operation took 55 seconds from lowering of life-line to the moment the Sycamore—for all the world like an angry bull—bucked, swished its tail rotor, and charged off. Demonstration of a Vampire T.11, handled by F/O. A. Brindle, was no doubt of personal interest to Gen. Raffaelli, who is said to be a competent performer on Italian Air Force Vampires.

The final curtain-call—a fly-past by each aircraft—was preceded by a single C.F.E. Hunter (F/L. E. S. Chandler), which, after an immaculate loop, flashed past the tower like a mackerel-spinner.

On the evening of November 22nd Gen. Raffaelli and his wife were guests of Sir William Dickson and Lady Dickson at a performance of *Kismet* and afterwards at supper.

The following day the general drove to Northwood, Middlesex, to inspect the methods and operation of Coastal Command, and to discuss with the A.O.C-in-C., Air Chief Marshal Sir John Boothman, the joint system of control in which are combined the interests of Naval and air operations.

That evening a reception at the Italian Embassy, where the air attaché Colonel G. Pelosi was host, rounded off an official visit which, pleasantly free from stuffy formality, appears to have been greatly enjoyed by the general and his staff.

MR. MAUDLING ON MODERN WEAPONS

ADDRESSING the Light Metal Founders' Association in London recently, the Minister of Supply, Mr. Reginald Maudling, said that he was "very concerned" at the growing cost of providing the armed Services with the modern weapons they must have if they were to play their part in the defence of the country and of the free world.

There were two particular problems. One was the growing complexity of modern machines. "Comparing one of our latest bombers with the war-time Lancaster," said Mr. Maudling, "each one now involves about three times as many man hours in production, nearly five times as many separate component items, and costs about ten times as much. They include something in the region of one and a half acres of light alloy sheets and some twenty-five miles of electric cable."

The Minister continued:—

"The second problem is that a new generation of weapons such as guided missiles is coming into being. We must not fall behind others in the development of this latest means of defence, costly as the process of development necessarily is. Yet while we are developing this new generation of weapons, we still have to maintain and improve the weapons of the present generation. Clearly a period of transition is a period of heavy expense because we cannot take the risk of abandoning the development of the weapons we know until we are quite certain that the newer weapons will fully do the job."

HERE AND THERE

SPECIAL EQUIPMENT fitted to this S-51—owned by Autair, Ltd.—one of two which recently left on the Hunting Aerosurvey expedition to Grahamland, includes bag-type buoyancy gear, designed by R.F.D. (the starboard bag is here seen inflated) and skid gear to prevent the machine from sinking in soft snow. The skid gear was built, to Mr. W. H. Armstrong's specification, by Eagle Aircraft Services, Ltd.

Supersonic Lockheed Airliner?

A NEWSPAPER report earlier this week, as yet unconfirmed by Lockheed, hinted that the company is offering to the airlines for delivery in 1965 a supersonic 200-passenger jet airliner. Cruising speed was given as 1,000 m.p.h. at 60,000ft.

France's Sharp Weapon

ONE of the most significant military aircraft built since the war is France's S.N.C.A.S.O. Trident mixed-power interceptor which, according to M. Jean Crouzier, Secretary of State for the Armed Forces, has already exceeded Mach 1.3. M. Crouzier added that it has also executed a roll at supersonic speed and that the Trident II has been planned to use a 1,200-metre runway.

American Jindiviks

THE Australian Minister for Defence Production, Sir Eric Harrison, has stated officially that the U.S. Armed Services are to use the Australian-designed Jindivik pilotless aircraft. East Coast Aeronautic Incorporated of New York (a subsidiary of the Barium Steel Corporation) is named as the licensee. There will be little disagreement with Sir Eric's contention that the licence reflects great credit on the Australian aircraft industry, in particular the team of designers at the Government aircraft factory at Fishermen's Bend, Melbourne.

S.T.O., not V.T.O.

SPEAKING at Philadelphia to some 200 makers and designers of V.T.O. aircraft, Lt-Col. John L. Klingenhagen, a member of the research and development staff of the U.S. Defense Department, has stated that his department was switching its interests from V.T.O. aircraft to those capable of very short take-off and even shorter landing. He gave as the reason that V.T.O. aircraft were unable to carry a reasonable load per horsepower in comparison with aircraft taking off horizontally. At the same gathering J. F. "Skeets" Coleman, who has now made over 400 V.T.O.s and landings in the Convair XFY-1, and about a dozen "push-overs" into level flight, stated that he was satisfied with the aircraft "and its future performance."

Developed for Christmas

NEXT Wednesday's issue of *Amateur Photographer* is to be a special Christmas number containing, among other seasonable features, suggestions for Christmas gifts to camera enthusiasts.

W.J.A.C. in the Air

DURING the past season 1,500 cadet members of the Women's Junior Air Corps have been given flights in the Corps' aircraft—an Auster Aiglet which has replaced the original Fairchild. Women pilots who have taken the aircraft on its week-end visits to local units of the W.J.A.C. have included Miss Freydis Leaf, Mrs. Anna Daab, Miss Lettice Curtis and Mrs. Diana Barnato Walker.

Miss Freydis Leaf to Marry

THE W.J.A.C., incidentally, will be losing the valuable services of Miss Leaf, for we learn from South Africa of her engagement to Timothy, younger son of the late Col. A. A. Sharland and Mrs. Sharland. The marriage is to take place in Natal on December 31st at St. Agnes Church, Kloof. It is understood that Miss Leaf—who was British Air Racing Champion in 1954—intends to settle down to farming in South Africa.

WEATHER AWARD: One of the Groves Memorial Prizes is presented to F/L. J. Formby, who has made more than 500 meteorological flights. The award—one of those established by Maj. and Mrs. K. Groves in memory of their son, who lost his life on a weather sortie in 1945—was made by Maj. Groves himself at an informal Air Ministry ceremony last week.

World's Least Experienced Airline?

AN agency report from Berlin says that Western observers there are puzzled by the fact that nothing has been heard of the East German Airline since the ceremonial departure for Moscow of its first service on September 16th. The airline is reported to be equipped with a single Il-14. The report adds that the "fleet" is at present stored in a hangar at Schonefeld, East Berlin.

Alvis on the Airfield

IN his address to Alvis shareholders, issued in advance of the annual general meeting on December 13th, Mr. J. J. Parkes (chairman) states that development of a new suspension and transmission layout has enabled the company to obtain a production order for a quantity of chassis for a new design of R.A.F. fire and crash tender to operate at a total weight of 12 tons. "Unique cross-country properties" are promised.

Japanese Sabres

FROM Tokyo comes a report that orders are soon to be placed by the Japanese Defense Board to enable two aircraft manufacturers to go ahead with plans to build jet aircraft with Japanese materials. Formal orders are to be placed with Kawasaki and Mitsubishi for 70 North American Sabres and 97 Lockheed T-33 trainers. The first T-33, assembled from American-made parts, will be delivered in January 1956 and eight others should follow in March. Mitsubishi plans to deliver 27 Sabres in the 1956 financial year and 43 in the following year. Lockheed Aircraft announced on Monday that Theo Limmer, one of their pilots, is going to Japan to organize a flight-test programme.

Recognition Words and Deeds

THE Aircraft Recognition Society's "December Forum" will take place on Wednesday, December 21st, at 7 p.m. in the library of the Royal Aeronautical Society, when the panel will consist of Mr. Peter Masefield (the president), Sir Arnold Hall, W/C. Roland Beamont, Mr. C. H. Gibbs-Smith and Mr. E. Colston Shepherd (panel chairman). All aviation enthusiasts are invited. The Society's 9th All England Aircraft Recognition Contest takes place on January 21st, when teams from Holland and the U.S.A.F. are expected to compete. Entries close on December 31st; details are obtainable from the Hon. Secretary, The Aircraft Recognition Society, 15 Tavistock Street, London, W.C.2.

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(Left) W/C. Gibb receives his diploma from Capt. K. J. G. Bartlett, president of the F.A.I. (Right) Mr. P. B. Mayne, R.Ae.C. official timekeeper; Mr. W. Goldsmith of the R.A.E.; Col. R. L. Preston, R.Ae.C. secretary-general; Mr. B.G. Markham of the Bristol engine division; and W/C. Gibb.

A Record-holder Entertained

R.Ae.C. Dinner to W/C. Gibb of Olympus-Canberra Fame

GUEST of honour at a dinner given by the Royal Aero Club on Tuesday of last week was W/C. Walter F. Gibb, D.S.O., D.F.C. The occasion was in recognition of his two world aeroplane altitude records on the Olympus-Canberra. Diplomas were presented to W/C. Gibb and to Mr. Basil Markham, of the Bristol engine division, by Capt. K. J. G. Bartlett, president of the F.A.I.

Col. Preston, secretary-general of the R.Ae.C., said in introducing W/C. Gibb that the height record was technically the most difficult to obtain. He paid a tribute to the work of Mr. W. Goldsmith and the Farnborough team in connection with both altitude records and world speed records, and he mentioned that it had taken some 40 pages of calculations to prove that the height record had been broken, and to obtain an accurate figure. It was noteworthy, he said, that the absolute record was still held by a balloon [Capts. Anderson and Stevens, U.S.A., November 1935] which rose 6,505ft higher than the present world aeroplane altitude record (confirmed by the F.A.I.) made on August 29th. Gibb's first record, of May 4th, 1953, was 19,406metres (63,668ft), and technically it was necessary to exceed this figure by 3 per cent, or 1,910ft. In fact, the new record of August 29th, 1955, was 20,083m (65,890ft) or 2,222ft more than previously. Thus the new record was set by the narrow margin of 312ft.

After the presentation of the diplomas, W/C. Gibb was asked to talk about the record flight. Doing so briefly, he mentioned that for the second occasion considerable trouble had been taken to reduce the weight of the Canberra; for example, instead of the normal two generators and two starters, it carried only one generator, the two starters having been removed after they had got the Olympus turbojets turning.

W/C. Gibb then referred to the very small margin between critical Mach number and stalling speed, and said that at top altitude it was certainly "twice as difficult to come down as to go up." It was not just a matter of shutting back and coming down, and he had felt that to hold the controls still he needed hydraulic jacks for arms. On the occasion of his first record, it had been cloudy with the weather deteriorating below, but on the more recent attempt the weather was perfect and he could see the ground clearly 12 miles below. With the jet-pipe temperature given to him in his briefing, it looked as though the record would not be obtainable, so he had come down a bit, used some more fuel and tried again—and made it with a few hundred feet to spare.

Mr. Basil Markham added his opinion that "this was a pilot's record if ever there was one"; it was Wally Gibb's enthusiasm which had fired the team preparing the aircraft. The flight had been made six days after approaching the Aero Club. No one could have given better judgment or better piloting than Gibb.

RESEARCH BENEATH THE SURFACE

ANTHONY FOKKER used to say that aviation progress from the stick-and-string days would have been far more rapid if designers could have seen airflow struggling past their structures, in the way that marine architects can watch water swirling past their ships.

We remembered this when we were invited recently to inspect the Admiralty's new Underwater Hydrodynamic Laboratory at Bushy Park, Teddington, and were somewhat shaken when Mr. F. S. Burt, head of the Fluid Dynamics Division, admitted that the shapes of underwater weapons have not been improved since Whithead chose a long cylindrical can with a spherical nose to house the works of his torpedo many years ago.

The main object of the new £1,100,000 facility is to develop better shapes for underwater objects, particularly guided missiles, and it was good to learn that Britain is leading the world in this research. It has much in common with aerodynamic wind-tunnel testing and will, of course have some effect on the design of Naval aircraft built to carry weapons developed in the Laboratory.

Smallest of the major items of research equipment at Teddington is a 29ft-long glass-sided tank for investigating the all-important problem of getting air-to-underwater missiles to enter the water cleanly. Two-inch-diameter scale models of the missiles are fired into the tank by a compressed-air, slotted cylinder catapult, based on the Navy's aircraft-carrier steam catapult. The angle of entry is variable, and pitch and yaw can be introduced to simulate airborne launching conditions. Models enter the water at speeds up to 180 kt, corresponding to about 570 kt full-scale, and their behaviour is photographed by a five-lens camera which operates at a rate of 1,000 exposures a second.

An even more remarkable 100-lens camera, offering exposures at the rate of 50,000 frames a second, was shown in the building housing the main water-tunnel, which is very like an aviation wind-tunnel. Normally a tunnel of this kind, with a 30in-diameter jet, will give accurate results only for models up to 5in diameter. But Admiralty Research Laboratory technicians have developed a new type of slotted-wall working section, which takes the form of a horizontal cage of Perspex bars enclosing the jet of water inside a larger observation chamber. In this, self-powered models up to 10in diameter and 10ft long (half the size of a conventional torpedo) can be tested in water speeds up to 35 kt and at pressures of 2 to 45 lb/sq in.

The most spectacular item of equipment at the new laboratory is a 60-ton, 122ft-long rotating beam, inside a domed building which looks, from outside, like a slightly smaller version of the Festival of Britain Dome of Discovery. In operation, the beam is rather like a centrifuge, and can drive models up to 20ft long at up to nearly 100 kt, five feet below the surface of an annular channel of water. A D.C. motor of 1,500 h.p. continuous rating supplies the power. Superb designing, involving the use of side "beaches," underwater baffles and spray deflectors, keeps water disturbance to a minimum, and the million gallons of purified water in the channel is so clear that objects 100ft away can be seen perfectly from two underwater observation chambers. The underwater shots in the new film *Cockleshell Heroes* were photographed from one of them.

While we were there, a half-scale torpedo was whirled around the channel at a speed of about 40 kt. The effect was almost frightening, and very impressive, because the small amount of water disturbance caused by the weapon's passage had quite disappeared by the time it came round again. Centrifugal forces of 14g are induced at top speed and banana-shaped models are often used to keep these g effects to a minimum. All forces acting on the model can be measured accurately, and tests can be photographed from the observation chambers. In addition, a television camera has been attached to the rotating arm to give a "live" picture of the behaviour of the model under test.

The first "all-air mail" for Australia was aboard H.P.42 "Hengist" when it left Croydon on December 8th, 1924.

"Flight" photograph

Kangaroo Route Comes of Age

B.O.A.C. and Qantas Celebrate 21st Anniversary of London-Sydney Partnership

PIONEERING days will be recalled on December 8th when, on opposite sides of the globe, two great anniversary dinners will be held to celebrate the 21st birthday of regular air services between Britain and Australia. In London, the occasion will be marked by a dinner at the Dorchester Hotel at which H.R.H. The Duke of Gloucester will propose the toast of "The Partnership," to which Sir Miles Thomas and Sir Hudson Fysh, chairmen of B.O.A.C. and Qantas respectively, will reply. A comparable function will be held at Sydney, where Major J. R. McCrindle will represent the board of B.O.A.C.; and receptions will be held at stations all along the 10,000-mile route.

It is timely, therefore, to review events leading to the inauguration of the first scheduled air service between Britain and Australia 21 years ago, and the subsequent progress made both in improving the service and in consolidating this great Commonwealth partnership.

It was in March 1919 that the Australian Government offered a prize of £10,000 for the first Australian airmen to fly a British aircraft from England to Australia in 30 days. The winners—Capt. Ross Smith, Lt. Keith Smith and Sgts. Bennett and Shiers—left Hounslow in their Vickers Vimy on November 12th, 1919, and arrived in Darwin on December 10th.

Nearly 15 years were to elapse, however, before the aim of regular services became a reality, but there were many outstanding flights during that waiting period. In 1926 came Sir Alan Cobham's journey to Australia and back in a D.H. 50 seaplane—along a route to be followed later closely by Empire flying-boats of both B.O.A.C. and Qantas. January of the following year saw the inauguration of an Imperial Airways service between Cairo and Basra, the first section of an eastwards Empire route—and in 1928 the late Bert Hinkler's Avro Avian completed the England-Australia trip in 15½ days. Two years later Sir Charles Kingsford Smith covered it in just under ten days. Meanwhile Imperial Airways had, in March 1929, extended their eastward route to Karachi.

The forerunner of Australia's international airline, Qantas, came into the picture in 1931 when, in conjunction with B.O.A.C., they made two experimental airmail flights between Brisbane and London. The pilots of the two D.H. 50Js which operated the Brisbane-Darwin section of the route were Sir Hudson Fysh and Capt. Russell Tapp, now the airline's London manager.

The year 1933 brought further extension of the Imperial Airways service (first to Calcutta, next to Rangoon and finally, in December, to Singapore) and brought an Imperial Airways/Q.A.N.T.A.S. agreement to associate in submitting tenders to the Australian Government for the Brisbane-Singapore airmail contract. The first airline survey of the complete route was made in that year by an Imperial Airways Atalanta (*Astraea*) which carried Sir Hudson Fysh as a passenger on its return to the United Kingdom. One outcome of his visit was development of the 10-seat D.H.86A for service with the Australian airline.

Combined British and Australian interests in the Kangaroo route led to the formation, on January 18th, 1934, of Qantas Empire Airways, in which Imperial Airways and Q.A.N.T.A.S. (the original Queensland and Northern Territories Air Services, Ltd.) each held a 50 per cent share. This new company was formed primarily to operate the Brisbane to Singapore section of the route with Imperial Airways connecting Singapore and London. Eastward services began on December 8th, 1934, with the departure from Croydon of *Hengist*, one of Imperial Airways H.P.42s, in their time the largest, and the only four-engined, airliners in regular service. Initially the service carried mail only and the first through passenger service was flown on April 13th. Flown in many stages, the route between London and Brisbane, as then operated, measured 12,722 miles and was the longest in the world; the through journey occupied 12 days. The Brisbane-Singapore section of the route, operated by Q.E.A., was officially opened by H.R.H. The Duke of Gloucester on December 10th, 1934. For the first few weeks Imperial Airways operated the Darwin-Singapore section under contract to Qantas but delivery of the Australian airline's D.H.86s enabled Qantas to take over in February 1935. By May of the following year frequency over the whole route had been increased from once to twice weekly.

The next milestone in the history of the route was the introduction of Empire flying-boats, in March 1937, on the

Loading mail aboard the first D.H.86A to operate the Qantas section of the original partnership route between Croydon and Brisbane.

(Right) Departure of B.O.A.C.'s first Lancastrian service from London Airport to Sydney, on May 28th, 1945. Lancastrians reduced journey time to 63 hours, but accommodated only nine passengers.

(Below) Short Empire-class flying-boats, one of which is seen at Berth 108, Southampton, were introduced on the U.K.-Australia route in July 1938, bringing new standards of comfort to the longest regular air journey in the world. The trip, in some 30 stages, took 9½ days.

U.K.-Alexandria sector. One of the boats, *Centaurus*, made a demonstration flight to Australia and New Zealand in December of that year, and in July 1938 through flying-boat services between Southampton and Sydney were inaugurated, reducing journey time to 9½ days. While the Singapore-Sydney section of the route remained under the control of the Commonwealth government, Empire boats of both operators were now making through journeys between Britain and Australia.

By August 1938 the boats were operating at a frequency of three return services weekly, and though the outbreak of war brought a reduction in frequency it was not until 1940, when Italy entered the war, that the route was altered. West of Cairo the service was diverted to Durban; passengers for England continued their air journey from Khartoum, travelling *via* West Africa. When war spread to the Far East the service was maintained at first, but it operated under increasingly dangerous conditions; one of the flying-boats was lost in December 1941 and another in the following month, and 1942 brought about the temporary severance of all overseas air links to Australia.

Australia's Commonwealth lifeline was re-established in 1943, when Qantas opened a Catalina service on the 3,515-mile non-stop Indian Ocean route from Perth to Ceylon. Average transit time was about 27 hours, though one flight lasted nearly 32 hours. In 1944 the Catalinas were joined by two Liberators converted for passenger carrying and capable of making the crossing in 17 hours. Together these two types made 824 crossings of the Indian Ocean under very arduous conditions. It was during this period that the name Kangaroo service first came into use, though it did not then apply to the full U.K.-Australia route; the so-called "horseshoe" route *via* Karachi, Durban, Khartoum and West Africa provided the only connection with England.

Direct flights between the two countries were resumed in June 1945 by Lancastrians, which operated a fast (63-hour) service between Hurn and Sydney. B.O.A.C., who had taken over the interests of Imperial Airways five years previously, were responsible as far as Karachi, where Qantas took over the service.

The first full year of peace saw several important developments. Both B.O.A.C. and Qantas introduced the Short Hythe flying-boat, a "civilized" development of the Sunderland, operating on a 5½-day schedule and carrying up to 22 passengers. Qantas crews manned the Hythes between Sydney and Singapore. In October 1946 Qantas placed an order for four Constellations and in December of that year the Australian Parliament passed a bill providing for Australian government purchase of the equal Qantas and B.O.A.C. holdings in Q.E.A. A year later Qantas, now State-owned, introduced their new Constellations on the Sydney-London route at an initial frequency of three flights fortnightly. Meanwhile, B.O.A.C. were continuing to operate three weekly Hythe services and three express mail and freight services per fortnight with Lancastrians. Another year passed and B.O.A.C. introduced their weekly Constellation services—and began the withdrawal of Lancastrians and Hythes.

By February 1949 Constellations of the partnership airlines were operating all passenger services between London and Sydney at a combined frequency of seven return flights fortnightly. The subsequent story of the Kangaroo route has mainly been one of steady, unspectacular increases in frequency and aircraft capacity. Highlights have included the replacement of the London-Sydney Lancastrian freight service by a London-Singapore York flight, connecting in Singapore with a Qantas DC-4 (August 1950); the introduction of the first tourist service on the route (April 1954); and the introduction of the Super Constellation by Qantas (August 1954). Under an agreement concluded between B.O.A.C. and Qantas early in 1948 revenues earned from the Kangaroo route are pooled and shared in proportion to the capacity offered. Each airline is responsible for its own operating costs.

All the Australian airline's services are now operated by Super Constellations. Present schedules offer one first-class and one mixed-class flights weekly in each direction. B.O.A.C., still using L.749A Constellations, offer two first-class and one tourist flight weekly. Next year, it is hoped, will see the replacement of B.O.A.C.'s Constellation services to Australia by three return flights weekly with Britannia 100s; though frequency of the Corporation's services will not increase, use of the much larger Britannia will result in greatly increased seating capacity and faster schedules, as well as improved comfort. Qantas plan to introduce an additional Constellation service, so that passengers on the Kangaroo route should, for the first time in the long history of this service, be able to travel in either direction on any day of the week.

The future of the Kangaroo route, as well as its past, will provide much material for discussion at the anniversary dinners on December 8th next. Among the celebrities attending the London dinner, in addition to those named on page 830, will be the Minister of Transport and Civil Aviation, Mr. Boyd-Carpenter; the Postmaster-General, Dr. Hill; the High Commissioner for Australia, Sir Thomas White; the New Zealand High Commissioner, the Hon. T. C. Webb; representatives of the British manufacturers; and many past and present executives of Imperial Airways and its successor, B.O.A.C.

The L.1049C Super Constellation, used on all Qantas flights between London and Sydney, covers the route in 58 hr elapsed time.

HANDLING THE A.O.P.9

Auster's Versatile Spotter

By C. M. LAMBERT

"FLIGHT" PHOTOGRAPHS

NOW in full production and in service, the Auster A.O.P.9 fills a requirement formulated some time ago by the Army for a new A.O.P. machine with a good deal higher performance and more elaborately equipped than its predecessors. In fact, the aircraft which resulted was for Austers a completely new design, the many noteworthy features of which were described in *Flight* of June 11th, 1954. The requirement related in the main to artillery spotting work and general reconnaissance, with the possibility of quick adaptation in the field for such missions as telephone cable laying, leaflet-dropping, photography and sky-shouting, and—with dual controls—training.

The result is naturally an aircraft with a specialized performance in which emphasis has been laid on the ability to operate from really rough and very small fields, with all the handling characteristics and aerodynamic features that this requires. Add a very comprehensive range of equipment, such as navigation and landing lights, downward identification lights, oil dilution, carburettor air filtration, pitot head and camera heating, full blind-flying instrument panel, cartridge starter and drooping ailerons (all this with a structure largely metal-covered) and there emerges an aircraft with a not-excessive cruising speed but a very low stalling speed and excellent handling characteristics.

The undercarriage has large-tyred wheels, with single-disc hydraulic brakes operated by the pilot's toes. Undercarriage springing is by small Dowty Liquid Spring units in compression under the cabin floor. The performance of this gear during landing and taxying on rough ground is remarkably good, but ground handling is further facilitated by the addition of a hydraulically sprung tailwheel linked through springs to the rudder cables.

The A.O.P.9 carries as standard fittings a 500W generator, a 15 amp/hr battery, a STR9X 11-channel V.H.F. radio and an A.62A H.F. radio with a trailing aerial deployed from a winch in the cabin roof through an eyelet on top of the rudder. A mixer box allows the selection of various combinations of intercom, V.H.F. and H.F., with the additional assets of a mute switch with spring-loaded and fixed positions. But for the military pilot probably the most welcome feature, apart from excellent handling qualities, is a really advanced standard of comfort. The seat cushions are deep and soft and, though the rudder pedals are not adjustable, each of the two front seats can be moved on the ground over a wide arc so that as the seat is moved forward it also rises upwards. There is plenty of elbow room.

Controls are normally provided for one pilot only (dual can be quickly fitted) and round his seat are grouped a crowbar and a map pocket (in the left hand door), a Very pistol conveniently housed in the centre of the cabin floor, and a fire extinguisher between the front seats. Hydraulic flap-selector and pump are in the cabin roof structure above his right hand, close to the trailing aerial winch. The front passenger's seat has the H.F. radio and V.H.F. selector and mixer box mounted right in front of it, and is provided with a convenient foot-rest. The access door on each side shuts tight and the positive-locking catch is large and protected by an efficient guard. Half of each side window is hinged at the top and can be swung out and locked in any position. They are very easy to open or shut, and when open no perceptible draught enters either the front or rear cabin. The observer's seat in the back can face either way and has plenty of leg room, a foot-rest and a separate access door. When facing rearwards the observer sits under a single-piece moulded transparency reaching down to knee height, through which he has a completely unobstructed view rearwards over the tail and sideways and downwards.

My first flight in the A.O.P.9 was, in fact, made as a rearward-facing passenger. I thoroughly enjoyed a grandstand view of the country around and much appreciated the very low levels of noise and vibration and the complete absence of draughts. Freedom from draughts can also be appreciated in either of the front seats, which I later occupied in turn; and most welcome of all on a November afternoon was a cabin heater which blew hot air on to the legs and—for demisting—up the windscreen. For warmer climes there is an adjustable punkah louvre in each front window from which fresh air could be directed onto any part of the body. After flying as passenger in the rear and front seats, I moved over to the pilot's position and prepared to try the aircraft in the rather misty weather prevailing at Rearsby at the time. The visibility at 300ft was about one mile, but above that it improved a little as the haze hung mostly close to the ground. Right in front of me in the aircraft was the standard six-instrument blind-flying panel in which the V.S.I. has been replaced by the two-needle r.p.m. gauge. The A.S.I. reads in knots from 0 to 140 and the altimeter is of the latest three-needle type. Immediately to the right of this are oil-temperature and pressure gauges and beyond that the H.F. radio compartment. Along the top of the dashboard runs a row of switches covering the lighting and other services, with the battery master switch at the extreme

On the ground or in the air the A.O.P. 9, for the R.A.F. here and for the Indian Air Force (top), has a purposeful appearance not belied by its performance. The range of upward aileron movement is clearly shown at left.

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HANDLING THE A.O.P.9 . . .

right-hand end. Centrally above the panel is the only magnetic compass, a simple E.2A stand-by instrument.

Above the centre of the panel two small hooded lamps on a single mounting can be pulled out on a sliding arm to light the instruments at the desired angle. Additional lights are provided for all other features, including the cylinder-head temperature dial mounted as an extra above the H.F. radio compartment. Below the centre of the dashboard is a group of four differently shaped knobs, cabin heater at top right, oil-cooler adjustment at top left, brake parking catch below, and push/pull throttle plunger in the centre. This last item has no friction control knob and no return spring, so it is very easy to move; a preset friction device makes it stay exactly where it is put. On a ridge running centrally down the floor are two vertical levers, a carburettor hot- and filtered-air selector (with a three-position gate) and the elevator trim lever, which moves freely. It controls a large tab on the port elevator and is very effective in flight.

Flap control is in the roof, as described above, and the cartridge starter toggle (with safety guard) and black and yellow striped door-jettison handle are down on the left away from all other controls. The petrol cock has three positions, "off," "on" and "on + prime," and is immediately aft of the trim handle and surrounded by a protective rail to prevent inadvertent kicking. Next to it is the Ki-Gass priming pump.

The engine was ready primed and warm, so I selected fuel on, master switch on, throttle "cracked" and magnetos on, and pulled about 9in of cartridge starter cable. The Bombardier started immediately and idled smoothly. The oil cooler was set, the filter lever in normal, the cabin heat on, the metal airscrew fixed pitch and mixture control automatic; so I had nothing to do with the engine but work the throttle. Taxying was perfectly easy, for the throttle control was sensitive; and, though the tailwheel steering was a little spongy, I found it easy to turn almost about one wing-tip on the grass at about 1,000 r.p.m. without using brakes. The brakes could be applied differentially or together to assist steering or to stop. They were reasonably sensitive and very effective. Visibility was little obstructed by the engine and shocks from rough ground well absorbed by the undercarriage. There was no tendency to swing or to lurch and, the undercarriage being mounted well forward, full brake could be applied at fairly high speeds without danger of nosing over.

I opened the throttle and kept the stick central. The A.O.P.9 started forward without any appreciable tendency to swing. At something under 30 kt the tail began to rise of its own accord and the aircraft flew itself off at about 40 kt. In subsequent take-offs I found that, if the tail was pulled down gently, as soon as it had begun to lift the aircraft flew off at about 35 kt, with one third flap down and ailerons drooped, and went straight into a very steep climb. The ailerons are large and heavily balanced and all controls feel steady but not at all heavy. By setting the flap selector lever to "up," the airstream can be left to blow the flaps up, and a few short strokes on the pump will lock them home. The sink after raising flaps is slight and gentle and the trim change negligible. Again, I found that taking off with one third flap, full power, and trim neutral, the gentle backward pressure would raise the aircraft off the ground, and flap retraction caused the nose to drop very slightly so that no trim adjustment was required until the speed had built up to over 80 knots, when the nose began slowly to rise. Maximum continuous cruise power of 2,300 r.p.m. resulted in an indicated speed of 90 kt at 1,000ft. The trimmer was a little sensitive but adjustment for hands-off straight and level flying was quite simple.

In this condition I made straightforward stability checks and found the ailerons neutral, with no evidence of control friction and only slight adverse yaw on initial application. However, adverse yaw is minimized by the aileron gearing and configuration, since the aileron nose projects considerably below the wing as the inboard aileron moves fully up, while the outboard aileron moves down only slightly. Fore-and-aft displacement from the trimmed attitude resulted in a very slow phugoid, which damped out. Use of the rudder with the stick free resulted in a greater response in roll than yaw, but the reaction was fairly sluggish.

The A.O.P.9 is mainly intended for use at the lower speeds and close to the ground, and it is obviously desirable that the classic precautionary landing, which is the normal A.O.P. practice, should be uncomplicated by any adverse characteristics. The next procedure I tried was, therefore, to slow down after trimming for cruising flight, by throttling back and progressively extending flap. Since the ailerons began to droop as soon as any flap was lowered, their effectiveness decreased slightly; but ample control remained right down to the stalling speed. Trim changes during the process of slowing down were very small and could easily be held without adjustment.

After this I returned to the airfield and landed, making the approach at 50 kt, at which speed the nose pointed where the aircraft was going and the angle of glide was pleasantly steep. The nose had to be pulled up some distance for the round-out, but there was ample control and speed did not fall off too quickly to allow a precise landing. Once down, the A.O.P. stayed ther and could be immediately controlled with the steerable tailwheel.

For the next take-off, I pumped down one third flap, set the trim at neutral, and opened the throttle with my hand off the stick. As the tail rose, I pulled the stick back and the aircraft got airborne straight away. I made a normal circuit at 1,000ft and came in to land again at 45 kt. This time, again, a fairly ample round-out was required to get the tail down, but firm braking after touch-down produced no adverse effects. With a

The close-up view as an A.O.P.9 flies by shows how the ailerons droop 10 deg as the flaps are lowered one-third. The angular tail is a most distinctive feature.

HANDLING THE A.O.P.9 . . .

fairly slow landing almost full brake can be used immediately and the resulting ground run is in the order of 60 to 70 yd, though with practice much shorter distances can be achieved. The brake pedals, incidentally, are really masculine affairs, easily capable of accommodating a large ammunition boot.

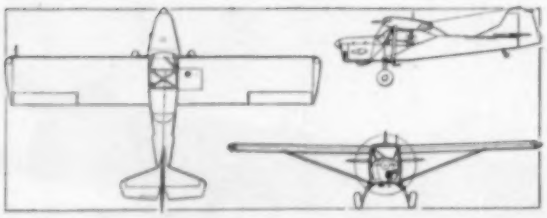
I took off again to make a circuit at 300ft, this time locking the side window open at an angle of about 45 deg. There seemed to be no significant increase in noise and only when the engine was idling on the ground could I feel the slipstream tapping on my left shoulder. The cabin did not seem to get any cooler and there was certainly no draught. I levelled off at 300ft and began to turn downwind and found that, with 30 deg of bank on, and after an alteration of course of about 45 deg, I could easily see the field over the top of the wing. This was not the case on the final turn-in; but, if a short, straight final approach was allowed for and the radius of turn known, positioning for landing would cause no great problem. Four full strokes of the pump brought down full flap with a very slight temporary nose-up trim change. After that the aircraft tended to steepen its angle of bank and slight pressure was required on the stick against the turn.

An excellent quality of the A.O.P.9 is that the throttle can be opened and closed without causing any serious attitude or trim changes. As the speed comes back below 45 kt (at this speed the A.S.I. has no position error) the nose must be pulled some way up to maintain height so that, at 40 kt, the aircraft can be flown on in the three-point attitude with full control remaining in all axes. Another excellent attribute is the fact that, because of the direct petrol-injection system of the Bombardier, the throttle can be literally punched open from the fully closed position and the engine will pick up without any hesitation and reach full power in about 2 sec. The overshoot from a glide approach with full flap can therefore be initiated safely at the very last moment and the resulting climb-away is very steep. Flap setting can very soon safely be reduced to one third.

I made a final take-off and climbed to 2,500ft. On the way up at 65 knots with full power and a clean aircraft, I climbed from 1,000ft to 1,500ft in 25 sec, and from 1,000ft to 2,500ft in 85 sec —a rate of climb of just over 1,000ft/min, with one occupant and a few gallons of fuel remaining. Climbing at this load at 60 kt would raise the rate of climb to about 1,200ft/min.

At 2,500ft I closed the throttle and allowed the speed to fall off, pulling the nose up to maintain height. The last bit of speed fell off very slowly indeed and the controls remained fully effective right down to the moment at which the A.O.P.9 faltered and lurched forward into the stall at 42 kt. At about 45 kt I thought I felt the faintest vibration in the tail, but there was no definite warning of the stall. The first sign is the hesitation as the airflow breaks away, and this is followed immediately by the nose dropping about 30 deg and one wing falling away. Aileron control remains but the wing drops far enough in the more decided stalls to make rudder preferable to aileron for keeping level. Speed builds up very quickly when the stick is pushed forward and recovery is immediate.

Though one might comment on the fact that there is practically no warning of the stall, it should be noted that the aircraft is not easily stalled and it takes a very long time for the last few knots of speed to fall off; in fact, an inadvertent stall would require extremely inconsiderate handling. These characteristics—firm stall without warning followed by dropping of one wing—became less accentuated in subsequent stalls, first with one-third flap and 1,800 r.p.m., and then with full flap and 1,800 r.p.m. In these cases, the stall came at 35 kt and 34 kt respectively with a height loss in the first case of 100ft or less and in the second case without any height loss measurable on the altimeter after recovery. The tendency of the wing to drop decreased as the stalling speed was reduced with flap. Full and precise control remained all the way down to the stall. The fitting of the strakes on the fuselage top decking has, I found, resulted in a very nose-down spin with a fairly high rate of rotation and no pitch oscillations. Recovery is completely straightforward.



AUSTER A.O.P.9
One Blackburn Bombardier Mk 203, 180 h.p.

Span, 36ft 5in; length, 23ft 8.5in; height, 8ft 5in; all-up weight, 2,125 lb; maximum permissible speed, 140 kt; cruising speed at 2,300 r.p.m., 90 kt; stalling speed, full flap, engine on, 33 kt; fuel capacity, 16 gal; maximum endurance, 2.5 hours. (Full illustrated description appeared in *Flight* on June 11th, 1954.)

I made my final landing by passing over a selected touch-down point at about 300ft in the landing direction and, lowering the flaps, going into a left-hand turn with about 30 deg bank. Though the touch-down point was out of sight in the turn, I kept up a constant bank and let the aircraft descend at 50 kt towards the low barbed-wire fence which marked the airfield boundary. I straightened up on the bearing and found myself properly lined up after a turn which can have had a diameter of very little over 300 yd. I had about 50 yd straight in, during which I throttled back and pulled the nose progressively up as the speed fell off to about 40 kt. In this condition, the tail hangs well down and I thought it prudent to apply a burst of power to clear the fence before dropping it on to the ground immediately beyond. Application of power had, however, upset the slow drag in and, when I touched on three points, the aircraft produced one of its very rare bounces. But there was ample control to put it down again in the three-point attitude without extra power, and I applied the brakes immediately. I stopped about 80 yd from the fence, a distance which, though not at all remarkable for this aircraft, showed what could be done with very limited experience of the type. Being then somewhat short of fuel, I returned to the apron and switched off.

The A.O.P.9 seems to be a very successful specialized aircraft and is amply endowed with that quality rare in military vehicles—comfort. Handling is perfectly straightforward and very simple, and I very much enjoyed its low speed and short-field landing characteristics. The situation, however, is not being allowed to rest there and one can expect further developments, probably in the form of a fuel tank in the port wing root. The 16-gal fuel load is at present carried in a single tank in the starboard wing root with the option of a 25-gal, long-range tank with electric transfer pump in the rear of the cabin. Meanwhile production continues and A.O.P.9s are being delivered to both the R.A.F. and the Indian Air Force. With the R.A.F. they are already in service in Malaya.

MORE POWER FOR THE AUTOCRAT

MANY owners of Auster J1 Autocrat aircraft will be interested in the news that a modification kit for the installation of the 130-h.p. Gipsy Major 1 engine, in place of the standard 100-h.p. Cirrus Minor 2, is now available. A much livelier all-round performance results and, in particular, the shorter take-off run and faster climb should prove advantageous to operators of training and joy-riding Autocrats. Here the extra power provides a more reassuring safety factor during peak engine performance with high loads.

The flying qualities of the modified Autocrat, which is known as the J1N, are improved with the replacement of the normal J1 type vertical tail surfaces by a fin and rudder of greater area. The rudder incorporates an aerodynamic horn-balance and gives better directional stability and control. Accompanying the increased power of the engine, the fuel consumption rises from 5-5½ gal/hr (Cirrus Minor) to 6-6½ gal/hr (Gipsy Major 1). The overhaul life of the Gipsy Major is at present 1,500 hr, compared with 600 and 800 hr on the Cirrus Minor 2 and 2A respectively.

The Auster Company state that Gipsy Major 1 engines intended for use in this conversion should be fitted with dual fuel-pumps and will require slight modification to certain controls. For temperate conditions, double scavenge pumps and oil cooler are not necessary. A wooden airscrew, part No. D.H.5220/P25 or P26 is suitable; alternatively a metal airscrew can be fitted, with an all-round improvement in performance.

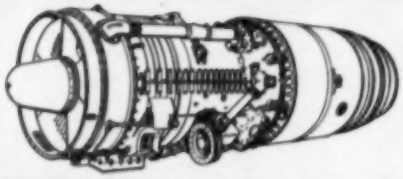
First club operators of the J1N are the Christchurch Aero Club, the Portsmouth Aero Club and the Coventry Aero Club.

AUSTER AUTOCRAT Type J1N
(Gipsy Major 1)

(Performance at 2,000 lb a.u.w. in standard conditions)

Take-off run (no wind)	160 yd
,, ,, (5 m.p.h. wind)	135 yd
Distance to clear 50ft (no wind)	380 yd
,, ,, ,, ,, (5 m.p.h. wind)	325 yd
Landing run (no wind)	155 yd
,, ,, (5 m.p.h. wind)	125 yd
Total landing distance from 50ft (no wind)	430 yd
,, ,, ,, ,, ,, (5 m.p.h. wind)	365 yd
Initial rate of climb	710 ft/min
Time of climb to 5,000ft	8½ min
Service ceiling	15,000ft
Cruising speed at 2,100 r.p.m. at 1,000ft	105 m.p.h. I.A.S.
Maximum speed at 1,000ft	126 m.p.h. I.A.S.
Fuel consumption at 2,100 r.p.m. cruise	6½ gall/hr approx.

THE *FAIREY* DELTA 2



POWER UNIT . . . *One Rolls-Royce Avon Turbojet*

How to go faster: the basic unchanging problem of aircraft design. Mach 1 is no longer the target; but higher Mach numbers present entirely new obstacles. The Fairey Delta 2 will play a part in the investigation and solution of these problems at newly-attainable speeds, showing the way to aircraft for the future needs of N.A.T.O. and the Western world.

THE FAIREY AVIATION COMPANY LIMITED · HAYES · MIDDLESEX

GYRON-SPECTRE

for the

MIXED-POWER-PLANT FORMULA

The **GYRON**
a most powerful axial jet engine designed to a formula embracing all the features which are indispensable for supersonic flight.

The **SPECTRE**
a liquid propellent rocket engine developing its maximum power at altitudes beyond the scope of air breathing engines.

THE DE HAVILLAND ENGINE COMPANY LIMITED

"Flight" photograph

High out of the water is a Short Sunderland 5 of No. 230 Squadron, Coastal Command, and low in the water is the first prototype Martin XP6M-1 SeaMaster. These pictures represent two eras of flying-boat design and are especially appropriate in an issue containing the first instalment of J. M. Bruce's story of the historic "F" boats (pages 842-846).

AIRCRAFT INTELLIGENCE

U.S.A.

Tanker Markings. The tails of the Boeing KC-97 tankers of Strategic Air Command are being marked with lights of different colours so that each B-47 bomber can hook up at night with the appropriate tanker. The object (*Aviation Week* reports) is avoidance of mid-air collisions similar to that which occurred over the Gulf of Mexico, when two B-47s closed in on the same red-lighted tanker and collided. One of the B-47s was lost.

Douglas DC-7. According to R. A. Dunlap, an aerodynamicist of Douglas Aircraft's Santa Monica division, the DC-7 would be 55 miles an hour slower if its level of aerodynamic cleanness were the same as that of the DC-3. Its range, moreover, would be 640 miles shorter and it would earn $380,000 a year less.

Lockheed F-104A. There is reason to believe that this highly supersonic straight-wing fighter will first be "unveiled"—i.e., pictures released—next February, when the first production machine is due off the line.

France

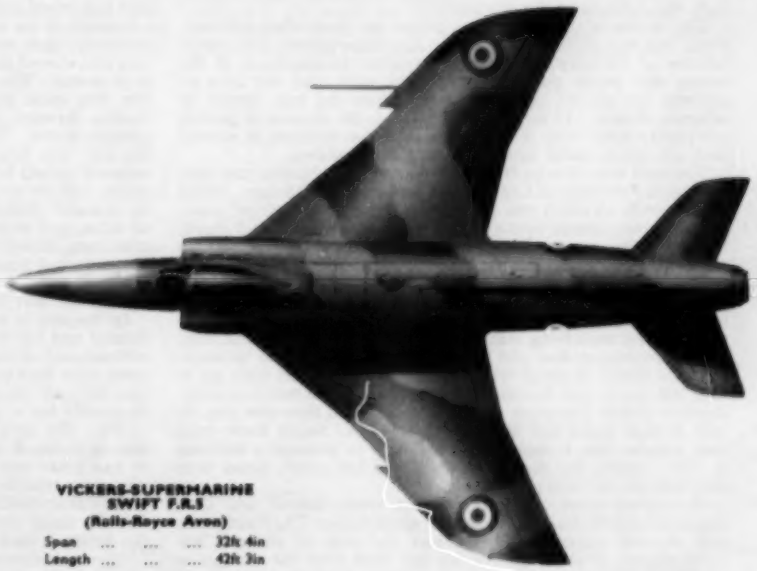
S.E.3130 Alouette II. Bearing the number 03, the first pre-production Alouette II helicopter was delivered to the French Navy a few days ago. Operational trials will be carried out at St. Raphael. The second pre-production machine is ready and the third should fly this month. The first production model will be delivered in March next year.

Nord 856N. Having successfully completed 90 hours of aero-towing tests, the four-seater all-purpose Nord 856N has undergone a series of modifications concerning, in particular, its cabin layout. Four people and 176 lb of freight, or two people and three parachutists or three stretcher cases can be taken. Loading is facilitated by a triangular door measuring 3ft 4in x 2ft 8in on the port side.

Nord 2501 Noratlas. At a recent conference M. Combard, director of U.A.T. and president of the Association of Independent Airline Operators, expressed his satisfaction with the Nord 2501 freighter as now in service on U.A.T.'s overseas routes. Having described certain modifications suggested by experience, he declared his company's intention of putting 12 additional machines of the type into service.

Morane Saulnier M.S.760 Paris. Having been shipped back to France after its New World tour, the Paris should now be flying again. During its 138 days of travelling and demonstrating the machine made 859 flights, amounting to 447 flying hours. Only 324 maintenance hours were required. Demonstrations were given in 40 different cities in 27 States, and the total of passengers carried was 2,139. Not a single demonstration had to be cancelled.

B.T.Z. Coleopter Drone. Professor Zborowski, of the Bureau Technique Zborowski, is working on the design of a coleopter target drone to be powered by a Rolls-Royce Soar turbojet.



VICKERS-SUPERMARINE SWIFT F.R.5
(Rolls-Royce Avon)

Span	...	...	32ft 4in
Length	...	...	42ft 3in

Supersonic Bale-out

The First Two Successful Escapes at Over Mach 1

The cockpit configuration of the F-100A, from which one of the supersonic escapes described below was made, can be seen in this view at Los Angeles International Airport. The aircraft shown came off the production line four places ahead of the one concerned in the account.

TWO pilots have this year successfully escaped from aircraft travelling at speeds in excess of Mach 1. One was American and the other British and, though both received injuries, each has largely recovered from his experience. In each case the aircraft went into a dive in which the speed built up and the controls malfunctioned in a way which made it impossible to pull out. One aircraft was a North American F-100A, on a manufacturer's test flight, and the other was a Hunter in squadron service. There is no reason to believe that the loss of control was caused by any basic default of either aircraft.

The pilot of the Hunter (as recorded in *Flight* of November 16th) was F/O. H. Molland. Though no detailed official report has been made public, it is thought that he baled out at 25,000 ft at an indicated Mach number of between 1.1 and 1.01, i.e., at a true air speed of between 710 m.p.h. and 765 m.p.h., and in a steep dive. The exact sequence of escape actions is not known, but during the escape he was subjected to a very high wind force. This was sufficient to strip him of gloves, helmet and oxygen mask, and to carry his arm back behind him, breaking it on the seat. Blast on his face gave him two black eyes. When he reached hospital his pelvis was also found to be broken. The automatic seat mechanism worked perfectly, however, and at the correct height, about 10,000 ft, his parachute opened and he descended normally. He landed in the sea off Felixstowe and was luckily picked up almost immediately by a range-safety launch. The Martin-Baker seat therefore appears to have performed its full duty in decelerating him and taking him rapidly in a stabilized descent down to the parachute opening altitude, where it pulled the rip-cord for him. But it could not protect his body entirely from the violence of the airstream.

The events of the American escape are somewhat different, partly because of the design of the American ejector seat, partly because of the very much less favourable circumstances of the escape and partly perhaps because the pilot had not time to perform the actions necessary to give him the best chance of escaping damage. In fact, at such a speed, the chances of getting completely away with it were remote in the extreme, as several previous unsuccessful attempts had already shown.

The man was George F. Smith, aged 31, production test pilot for North American at Los Angeles International Airport. Asked unexpectedly to test a new production F-100A, he took off wearing his flying overall over a sports shirt, nylon jacket and denim trousers. The weather had just cleared and he made a routine climb through cloud with the afterburner on and at a speed close to Mach 1. Seven minutes later he was at 37,000 ft and levelled off still with the reheat on. It was when he could not trim out the normal slight nose-heaviness as the speed built up that he realised that something was amiss. Thereafter the aircraft went into a steepening dive and the control column refused to move.

While Smith wrestled with the controls the speed built up to over 800 m.p.h. and he called on the radio that he was in trouble. Another North American test pilot in the area then saw him fly past at high speed and told him to bale out. Smith knew from past reports that it was considered fatal to attempt a bale-out at such a speed, but decided to try it as a last resort, rather than dive into the sea with the aircraft.

He pulled down the visor of his crash helmet and then throttled fully back and extended the speed brake. The Machmeter still showed supersonic speed and the rate of descent was 1,140 ft/sec. Without pulling his legs back onto the stirrups or otherwise taking up the ejection position he pulled the hood-jettison control and was immediately almost overwhelmed by a noise which he termed as the loudest continuous sound he had ever heard—something akin to a continuous explosion. This considerably unnerved him and he ducked forward to escape it, thus putting himself in a poor position for ejection. His head was almost on his knees, and with his feet still on the rudder pedals and left hand on the throttle he operated the ejection trigger in the right hand armrest of the seat.

The American ejector seat has no face blind and the firing and hood-jettison controls are in the collapsible arm-rests. The moment at which he is thought to have squeezed the trigger (and he has no recollection of actually doing this) was his last conscious moment for five days.

Some men in a motor boat on the sea below the F-100A were returning to port when their craft was shaken by a terrific explosion which nearly capsized it. Those on deck looked round to see a fountain of water spurt up a few hundred yards astern and understandably assumed it to be a mine or shell exploding. Then they saw, and examined through a telescope, an inert body falling with a torn parachute. Less than a minute after Smith struck the water the boat was alongside and he was pulled aboard. His shoes, socks, helmet, mask, gloves, watch and ring had all disappeared. His clothes were in ribbons and his face severely lacerated. His stomach had been so filled with slipstream air forced down his throat that—luckily—his body floated without inflated Mae West until his rescuers reached him. Severely shocked and delirious, he spoke only a few incoherent words on the way to hospital.

After the wreckage had been salvaged by divers, and witnesses interrogated, it was calculated that Smith had baled out at about Mach 1.05 at 6,500ft—an air speed of 777 m.p.h. He was subjected to a deceleration of 40g by the airstream, broadly equivalent to a body weight of 8,000 lb. Air pressure on him was 1,240 lb/sq ft. In the American seat there is no stabilizing drogue system to prevent toppling of the seat and to decelerate it before the harness is released automatically after two seconds free fall. After that a barostat in the pack releases the parachute as soon as the pilot descends below some 10,000ft. Smith therefore tumbled over and over and slowed down several hundred miles per hour in a fraction of a second. The clinical details do not make pleasant reading, but they must be given for the record. Smith's eyeballs were thrown forward against the lids and his internal organs were severely jarred. The end of his nose was torn off by the mask and his face was bruised and cut. The great blast of air on his stomach forced blood into his face, distending it beyond recognition, and the air forced down his throat had later to be removed by stomach pump. As the seat tumbled he was battered from all sides, and when he was released from it his parachute opened after two seconds and one-third of the fabric was torn away. His legs had been severely strained by flailing violently in the airstream, and his body was badly bruised by being battered against the seat in all directions.

In hospital it was found that Smith's small intestine was perforated and his liver badly damaged. He had no fewer than 20 subconjunctival haemorrhages in the eyes and it was thought for some time that he would not see again. But finally, after seven months and several operations, he has recovered sufficiently to qualify for a private flying permit, and has regained perfect vision. His eyes are, however, sensitive to glare and adaptation to darkness is slow. His liver is damaged to the extent that he can never take any alcohol again and his right knee occasionally gives trouble—a result of the flailing of his legs in the airstream after ejection. Before the accident Smith weighed 215 lb, but this figure dropped to 150 lb while he was in hospital. Now his weight is back to 175 lb.

The punishment that Smith received after ejection has been approached only by subjects on the U.S.A.F.'s rocket sled, and he is thought to have reached the very limits of human endurance. The case has been closely studied by many aero-medical experts, and the problem of protection during bale-out at such high speeds has been brought into sharp relief, especially since aircraft of such performance are now in large-scale squadron service with the U.S.A.F. The solution for such extreme cases as that of Smith is being sought in two types of jettisonable capsule cockpit now being actively developed for American aircraft.

MORE THOUGHTS ON THE P.1

—*with Reference to True Supersonic Efficiency*

DURING the past few weeks we have published several references to the problems of high-speed flight, from which it is possible to synthesize this further note bearing specifically upon the supersonic fighter. The previous references are: "A Note on the P.1" (September 16th), "The Area Rule" (September 30th), "A British Approach to Area Rule" (November 18th) and "Transonic Design—M.o.S. Statement" (November 25th). It is also pertinent to refer back to the three-part article by J. W. Fozard entitled "The Supersonic Fighter," which appeared in three successive issues dated 10th, 17th and 24th December, 1954.

PARTICULAR significance attaches to the recent Ministry of Supply announcement that, since its early flights in the summer of last year, the English Electric P.1 has frequently sustained supersonic speed in climbing flight—this, it may be supposed, without the use of reheat or rocket boost. It is well known that the use of rockets or afterburning entails a relatively high fuel consumption, sufficient to make the employment of such devices severely limited on a time basis. Since the space available for fuel in a high-speed fighter is restricted, this implies that a fighter which relies upon such devices for the attainment of the necessary performance must be limited to interceptions fairly close to its base, up to the maximum safe proximity to the guided-weapon zones. For example, it seems obvious that the Saunders-Roe SR.53 turbojet/rocket intercepter will be employed in such a manner, and will accordingly have a limited range but an altogether exceptional performance in the vertical plane.

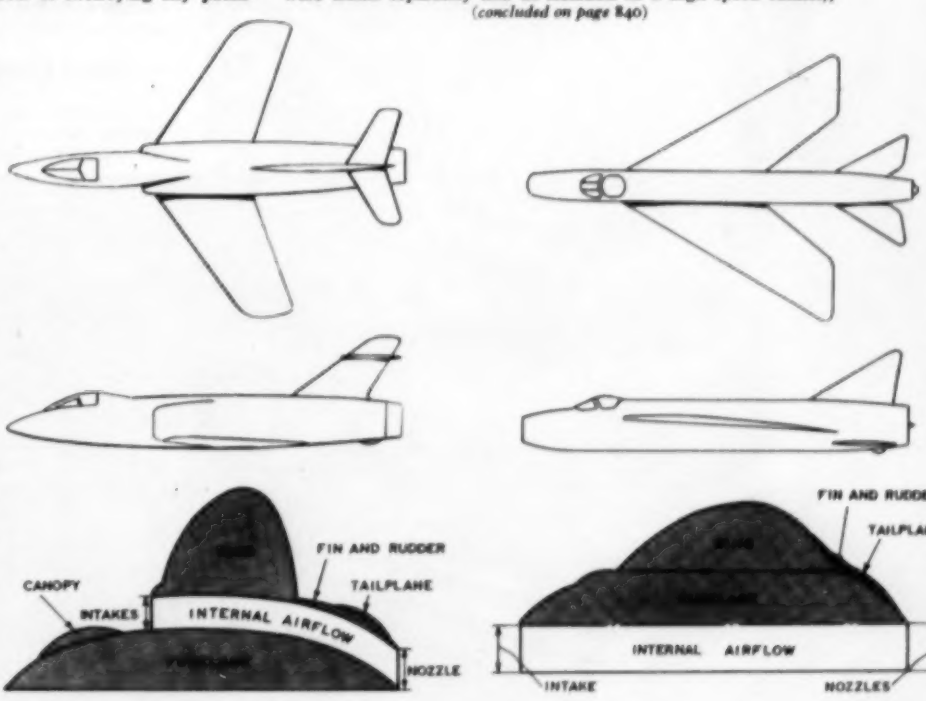
Conversely, although it seems logical that the P.1 should also be provided with afterburners, the performance already demonstrated suggests that the employment of reheat could be on a modest scale—perhaps only during the final manoeuvres required to intercept a high-flying target. The aircraft has also shown that it has all the manœuvrability required, and its aerodynamic characteristics should be such as to avoid the transonic troubles (at one time described officially as "the thunderclap hazard"), which would ruin the chances of most fighters against a bomber flying at a steady speed in excess of $M = 0.9$. The P.1's "very heavy armament", recently referred to by the Minister of Supply, would explain why the aircraft is larger than present subsonic-climbing fighters; and the fact that it has two engines will be welcomed by pilots who appreciate that complete power failure in a supersonic fighter not only results in a high rate of descent but may also lead to failure of the flight controls and other systems. A fighter capable of destroying any potential enemy aircraft at the greatest possible range and with the highest possible order of reliability would seem to be a key factor in the defence of the West.

As outlined in the articles referred to above, the drag rise at transonic Mach numbers is governed by what is generally known as the area rule. Application of this rule to the P.1 is possible with fair accuracy from the published three-view drawing. It results in the type of area distribution shown in one of the accompanying diagrams. The final result seems to give an almost perfect curve for minimum drag and, in fact, the Ministry of Supply stated recently (*Flight*, November 25th, page 808) that the aircraft was designed in full knowledge of the area rule. We cannot say to what extent the English Electric Co. were able to obtain true pictures of transonic flow over the P.1 during tunnel testing but it is appropriate to recall that the company have had a transonic tunnel at work for over three years—far longer than anyone else outside the N.A.C.A. In any case, flight testing of the actual prototypes must, by now, leave very few gaps in the company's knowledge of what they are doing.

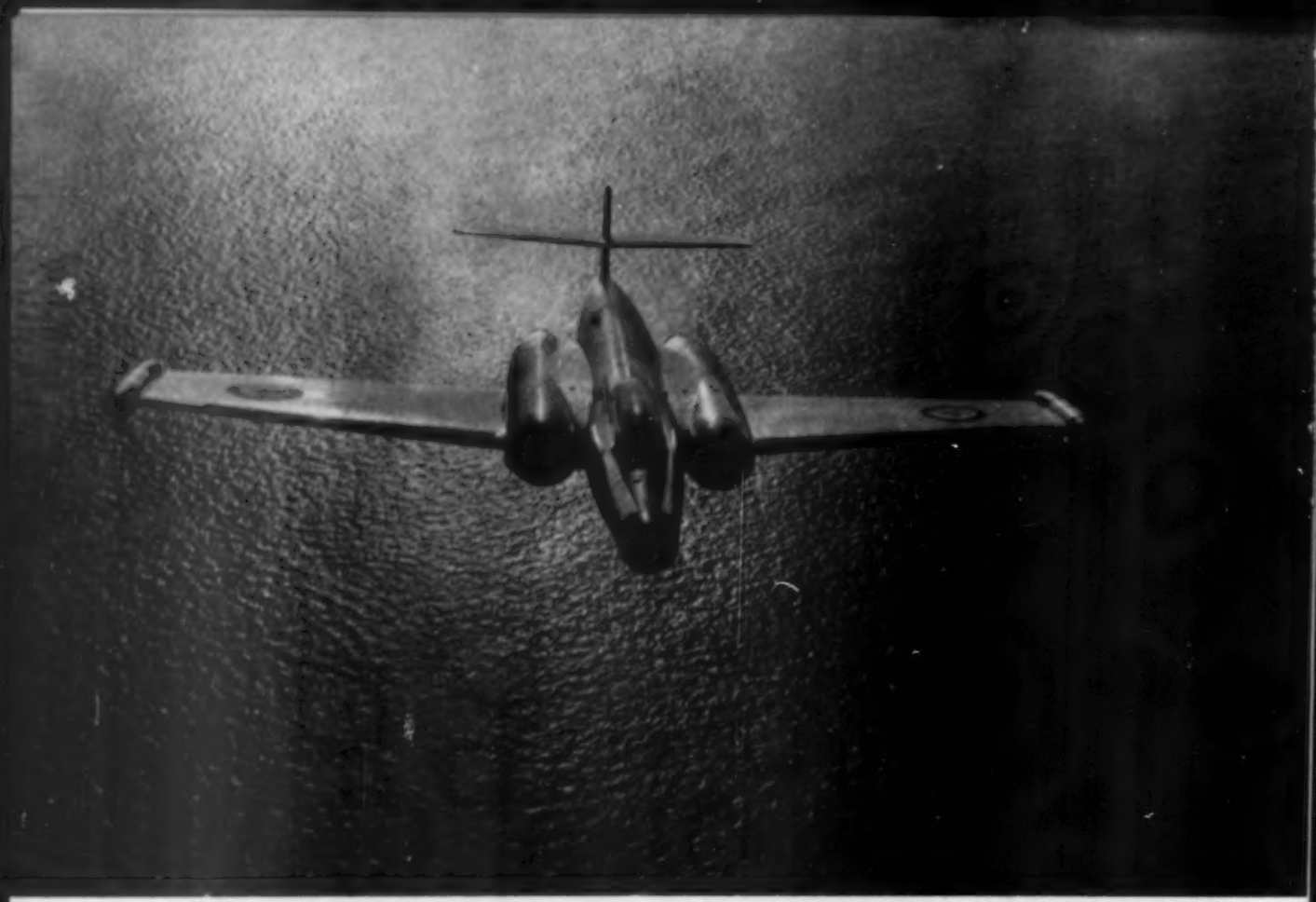
The neat way in which the complete design has been integrated to give the optimum result is clearly shown by the manner in which the drawing has been prepared. The highly swept wing required to avoid transonic handling troubles is seen to spread its volume over the entire length of centre fuselage, the latter having a constant cross-section in consequence. Admittedly, we recently described the P.1 as having "all the shapeliness of a suitcase" yet the area distribution, with all taper confined to the regions fore and aft of the wing, is seen to be completely in conformity with the area rule. The fall-off in cross-section at the rear is slightly reduced by the tail surfaces but this appears to bring the shape nearer to the optimum illustrated by the N.A.C.A.

In contrast, the other diagram shows how a fighter of more conventional appearance can prove to have a very bad area distribution. Although the hypothetical fighter illustrated would have slightly lower fuselage drag than the P.1 (if both fuselages were tested separately and in isolation in a high-speed tunnel),

(*concluded on page 840*)



These diagrams emphasize the fact that, although it may appear "unstreamlined" to eyes brought up on subsonic shapes, the P.1 (far right) has a much better distribution of cross-sectional area than aircraft of more conventional appearance.



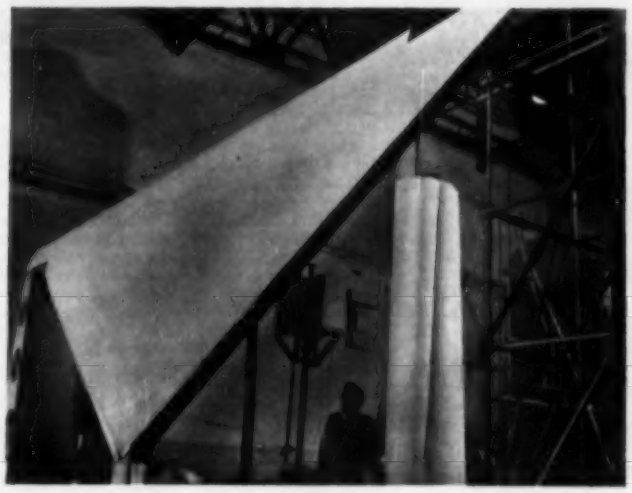
Canada's first all-weather fighter, the CF-100, seen above in a striking head-on view by Russell Adams, is a product of the Malton plant of Avro Aircraft, Ltd. (below). Not visible in the factory photograph are the Orenda Engines premises.

TEN YEARS AT MALTON

Avro Canada's Anniversary

North America's first jet transport: Avro Canada's C-102 Jetliner, which flew only two weeks after the de Havilland Comet 1 in 1949.

Malton, 1955: completed master models of major sections of the CF-105. Using these, production-type tooling is employed for prototypes.



IT was on December 2nd, 1945, that A. V. Roe Canada, Ltd., came into being as a new member-company of the Hawker Siddeley Group, on taking over from the Canadian Government the Victory Aircraft Factory at Toronto's Malton Airport. Last night, December 1st, 1955, Sir Roy Dobson was guest of honour at an anniversary dinner in Toronto at which he and Mr. Fred T. Smye, vice-president and general manager of Avro Aircraft, reviewed the company's ten-year history.

A. V. Roe Canada is now the parent company of three operating subsidiaries —Avro Aircraft, Orenda Engines and Canadian Steel Improvement—employing some 16,000 people. In 1945 the company began with only 300 employees, 200 of whom are charter members of the brand-new "Ten Year Club" (the first member—the company's No. 1 employee—being Mr. Smye).

Avro Canada's outstanding achievement has, of course, been the development of the Orenda-powered CF-100, the first military intercepter to be designed and built in Canada. Latest version is the Mark 4C, with 3-ft extensions on each wing, giving improved altitude performance. The first CF-100, Avon-powered, made its maiden flight on January 19th, 1950, only three years after commencement of the design.

The first jet transport to be designed and built in North America was the C-102, which first flew on August 10th, 1949, powered by Rolls-Royce Derwents. After much development flying, this project was shelved and the company's effort was concentrated on the CF-100.

The CF-105, delta successor to the CF-100, should appear in 1957; tooling and component manufacture is now well under way at Malton. This massive machine may well be powered by two Orenda PS-13 turbojets, which are to succeed the Orenda. Interesting production features employed on the CF-105 are the use of production-type tooling for the prototypes, and the use of phenolic resins and plaster in the construction of master models (illustrated on this page). These models incorporate an internal framework of steel and heavy-gauge aluminium.

On the powerplant side, the record of the Gas Turbine Division of A. V. Roe Canada—now Orenda Engines—is impressive. More than 2,500 engines have been built since September, 1952. Thrust ratings of Orendas have increased to over 7,000lb from the original 5,800lb, while weight has been reduced from 2,700 to 2,400lb. President of A. V. Roe Canada, Avro Aircraft and Orenda Engines is Mr. Crawford Gordon, Jr.

Avro Aircraft CF-100s at Malton.

MORE THOUGHTS ON THE P.1 (continued from page 837)

the supersonic drag of the P.1 as a complete aircraft would be very much lower. Together with its ability to bury its engines in the optimum shape of fuselage, this could well explain the apparent ability of the English Electric fighter to climb supersonically on two turbojets of moderate thrust without reheat.

It is, of course, possible to improve the performance of pre-area rule aircraft by adding to or subtracting from the cross-section of the fuselage at various stations, and this has in fact been done on some American designs. These belated attempts to make use of aerodynamic theory, much of which has been available for many years, cannot achieve the optimum result possible in a design which is area ruled from the start. Bulges and nipped-in waists are thought of as the hallmark of the area rule; but such an outlook is completely incorrect. The best supersonic aircraft have no such distinguishing features and any design which has is merely betraying the fact that it was incorrectly planned at the outset.

Thus, if the original design in our illustration (p. 837) had sufficient volume for its purpose, then an area-ruled development will have too much. Excessive volume can cause nearly as much supersonic drag as can a poor shape. For example, if the volume is 20 per cent more than it need be, G. N. Ward's formula suggests that the wave drag will be 44 per cent more than that of an aircraft having the same length and shape of area curve. Moreover, bulges can result in a weight penalty—particularly when they represent a modification of an existing design—which becomes severe for interceptions at 50,000ft or above. Alternatively, the loads set up in fuselage frames may be significant even when a double-curvature skin is assumed from the outset. It is also apparent that area ruling as a modification cannot be carried to extremes in correcting a basically poor shape.

Taking an extreme (absurd) example, if a cylindrical aerial mast were mounted on a supersonic fighter, the simple conception of the area rule would suggest that its drag could be reduced to zero by cutting out a cylindrical hole in the fuselage plating anywhere in line with the aerial. In practice, however, this would actually result in a drag roughly equal to that of the aerial *plus* that of the hole. This result could be changed appreciably only if the aerial mast were made extremely slender, and the hole likewise, the latter being adjacent to the mast. This conception of smooth, slender shapes is an assumption in the mathematical analysis upon which the area rule is based. (*Flight*, November 18th, 1955.)

No information has been released either in this country or the U.S.A. on the nature of the area rule for higher supersonic speeds, although the expert in fluid mechanics could devise appropriate rules from the wealth of aerodynamic theory that has already been published. But it does not need an expert to realise that a bulge designed for transonic Mach numbers will be wrongly shaped for higher Mach numbers and beyond a given Mach limit can actually increase the drag. At these speeds, the various components of the aircraft become less interdependent so that a good shape will be required for each individual component.

Nevertheless, it is possible to design a fighter such that, although area rule is followed to reduce transonic interference drag, the overall shape is also suitable for high supersonic Mach numbers with considerably inclined shocks. Undoubtedly the best American example is the Chance Vought F8U Crusader, an aircraft of the P.1 generation and not dissimilar from the British fighter in its shape of fuselage. A notable feature of this design is its high-mounted wing, which is particularly beneficial in reducing interference drag and in altering the flow of the streamlines across the aircraft as little as possible.

In contrast, the Lockheed F-104 design does not have a high wing, neither was it—in its conception at any rate—an area rule aircraft. On the other hand, the principles of its design are definitely weighted in favour of the supersonic regime, and the wing is of such small frontal area and volume as to be of less than usual significance in plotting the axial distribution of area. Two other contemporary supersonic shapes of exceptional interest are those of the Fairey F.D.2 and the SAAB 35, both of which are remarkable approaches to the problem of obtaining the highest possible performance from a single afterburning turbojet —a Rolls-Royce Avon in each case. The British aircraft has a true delta wing, of extremely low thickness/chord ratio, carried right up to the fuselage and meeting the latter at the mid position. The Swedish aircraft employs the double-delta configuration which, although less "clean-limbed", provides increased stowage space without penalizing the distribution of area.

None of the aircraft mentioned showed any obvious evidence of meeting area-rule requirements for minimum transonic drag. In the P.1, for example, nothing is apparent which should compromise the achievement of considerably increased Mach numbers when more powerful engines, with afterburners, become available. The importance of this trend towards more economical supersonic flight is apparent not only for the bomber but also for the fighter, which must maintain a supersonic cruising speed in order to intercept fast bombers well away from its base.

The P.1 appears to introduce a new era of aerodynamic shapes that will make the achievement of supersonic flight much easier and cheaper whilst retaining good characteristics throughout the transonic range—and also, incidentally, down to extremely low indicated airspeeds. It will be interesting to see what changes are made to the aerodynamic shape of the P.1 as the emphasis eventually turns to the upper end of the Mach scale. One may certainly expect revision of the main intake to avoid the occurrence of a single normal shock (we suggested this when we first referred to the aircraft over a year ago). Apart from this there may, in fact, be few superficial changes, for fighters must retain the ability to intercept subsonic aircraft for many years to come.

THE AERONAUTICAL BOOKSHELF

"I Burned My Fingers," by William Simpson. Putnam, 42 Great Russell Street, London, W.C.1. Price 18s.

ON the afternoon of May 10th, 1940, a Fairey Battle of the Advanced Air Striking Force was hit by light flak while attacking a German column advancing into Luxembourg. Unable to reach his base, the pilot landed in a small field in the Belgian Ardennes, where the Battle burst into flames. The pilot was trapped in his seat, but the observer and the radio operator/gunner managed to drag him clear and roll him in the grass, "smouldering like a dying torch," his face, hands and legs savagely burned.

That pilot, S/L. William Simpson, O.B.E., D.F.C., now tells the story of his long struggle to recover from his injuries, regain a normal place in society and to assist others similarly afflicted. As indicated, perhaps, by the title—*I Burned my Fingers*—this is a candid book which comes straight to the subject. Sensibly, the author neither dramatizes nor sugar-coats such topics as the physical and mental effects of disfigurement and plastic surgery. Any other approach might have defeated the object of the book, either by giving too rosy an impression of the very real but not unsurmountable problems faced by the "Guinea Pigs," or by hardening the reader's natural reluctance to associate himself with their suffering.

I Burned my Fingers is a success story. Its author's wounds have healed, and though the scars remain he enjoys good health; his life is "full to overflowing, free and independent." His work as a member of the National Advisory Council on the Employment of the Disabled for the past ten years has won him an O.B.E. We on *Flight* know Bill Simpson well as chief Press and information officer of B.E.A., a job which, he says, "has kept me going most hours of the day and often some hours of the night." His appointment has enabled him to practise his belief that the disabled person "ought deliberately to make himself conspicuous in his disablement—not only for his own sake, but to help others."

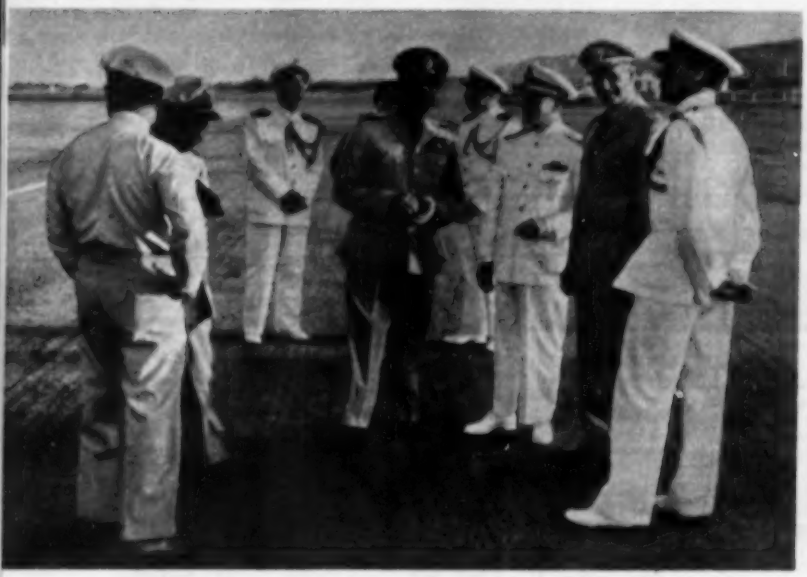
Simpson stresses that the scarred and disabled want not sentimental pity but encouragement and understanding: "We are more conscious of our remaining abilities than our obvious or hidden disabilities. We do not want anyone to feel sorry for us. We just want to be treated as equals and allowed and where necessary helped to live normal lives." Bill Simpson himself is today widely known and respected within and beyond aviation circles. His very readable book will increase that recognition and respect.

"A Picture History of Flight," by John W. R. Taylor. Hulton Press Ltd., Shoe Lane, London, E.C.4. Illustrated. Price 25s.

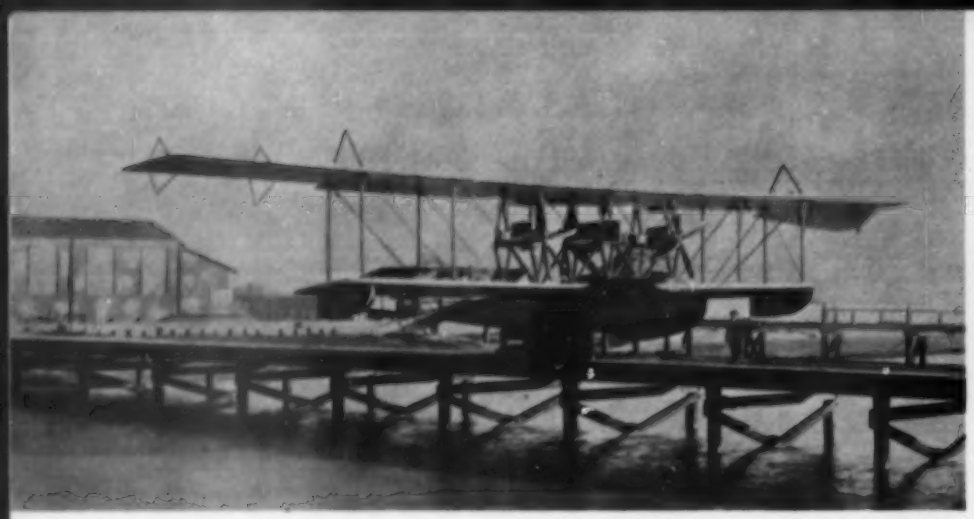
NOBODY was better qualified to undertake this work than John W. R. Taylor, still-youthful doyen of aeronautical archivists (though the dry-as-dust implication of the term is unfortunate, for Mr. Taylor's writing is always clear and bright). The book is a glossy quarto comprising some 190 pages wherein appear 648—no less—pictures, garnered from varied sources in many countries and each concisely and informatively captioned. The pages of commentary and introduction are a valuable contribution in themselves, and a few hours' browsing through the book (for it is the kind that invites infinite browsing) will equip a person with as much air-history as he is likely to need and afford him the utmost pleasure in its acquisition.

A book, this, for the shelf by the fire; a must for the school library, or any other library; and one to watch out for in the mess.

SHACKLETON TOUR



GLIMPSES of the recent Western Hemisphere tour by three Avro Shackleton M.R.2s of No. 228 Squadron. At the head of the page is the arrival at Gibraltar, with the morning mist veiling the Rock. Crews travelling in the Shackleton captained by F/L. H. C. Pretty, D.F.M., are lined up, while the A.O.C. Gibraltar, A. Cdre. G. G. Barrett, C.B.E., greets the visiting officers. At top right L.A/C. Barker is servicing a Griffon at Georgetown, British Guiana (shade temperature 107 deg). The Shackleton in flight (S/L. I. M. Harper) is beating up a line of Brazilian Air Force B-17s. On the left, at Recife, Brazil, A.V-M. G. W. Tuttle, C.B., O.B.E., D.F.C., force commander, chats with Brazilian naval and air officers. On the extreme right of the picture is Capt. J. C. Cockburn, D.S.C., R.N., British naval, military and air attaché in Brazil. Taking a breather at lower left is Cpl. Tech. W. W. Burns, and the last view depicts officers of the Venezuelan Air Force, with, third from left, W/C. K. MacK. Murray, D.F.C., officer commanding No. 228 Squadron. On the right of this picture is Col. Guerrero, Chief of the Venezuelan Air Staff.



The Porte Baby prototype No. 9800 in its original form; later the bow section was lengthened.

HISTORIC MILITARY AIRCRAFT No. 11

Part I

By J. M. BRUCE, M.A.

THE FELIXSTOWE FLYING-BOATS

WITH this article on a famous family of flying-boats—about which little detailed information has ever before appeared in print—Mr. Bruce resumes his popular series. He wishes to make grateful acknowledgement to Mr. Bruce Robertson, who has provided, together with certain other information, the data on serial numbers which will be published with the final instalment of this article.

IN 1909 a young British Naval officer named John Cyril Porte made his first practical entry into the field of aviation by building a small glider which, in company with Lt. W. B. Pirie, R.N., he attempted to fly at Portsdown Hill, Portsmouth. By the summer of 1910 Porte was experimenting with a little monoplane of the Santos Dumont *Demoiselle* type, powered by a 35 h.p. Dutheil-Chalmers engine. At that time he was stationed at the Submarine Depot, Portsmouth, and his monoplane's trials were conducted at Fort Grange.

By the following year Porte had fallen victim to pulmonary tuberculosis, and his Naval career was apparently prematurely terminated when he was invalided out of the Service. Despite his severe disability (for which medical science could at that time do relatively little) Porte remained actively interested in aviation. His aviator's certificate was issued by the Aero Club de France on July 28th, 1911; he had performed the necessary tests on a Deperdussin monoplane. Later in the year Porte was flying a Deperdussin two-seater at Shoreham, and by that time he had gone into partnership with Mr. D. Lawrence Santoni with the object of establishing a factory for the production of Deperdussin aircraft in Britain.

Flying-boats were probably a long way from Porte's mind in 1911: indeed, no boat had flown successfully at that time. Several "hydro-aeroplanes" had, however, succeeded in leaving the water. The first was the curious aircraft of Henri Fabre, which flew on March 28th, 1910; it was a canard monoplane fitted with crude floats and was quite unlike any other aeroplane. Contemporary with it, but less successful, was a Gabardini monoplane which had a true hull and came quite close to the later conception of a flying-boat. A clumsy German machine designed by Major von Parseval had appeared in 1909 but seems to have been unsuccessful.

The earliest recorded British attempt to produce an aircraft capable of rising from water was the Rawson-Barton Hydra-aeroplane of 1905. It did not fly, nor did the improbable structure designed by Mr. Jack Humphreys and built at Wivenhoe in 1909. The possibilities and potentialities of hydro-aeroplanes came to be recognized, but it was not until November 18th, 1911 that the first successful take-off was made by a British float seaplane. The aircraft was Cdr. Oliver Schwann's Avro biplane, which rose from the water of Cavendish Dock, Barrow-in-Furness, to make a brief flight. Six different pairs of floats had been fitted to the Avro before success was achieved.

Exactly one week later, on November 25th, the Waterbird left the waters of Lake Windermere. This aircraft had been built by A. V. Roe and Co. to the specification of the Lakes Flying Co., a group of friends headed by Capt. E. W. Wakefield. In 1909, Wakefield had publicly expressed his conviction that, at that time when aeronautical knowledge was sketchy in the extreme, the best type of aircraft to develop would be one which could rise from and alight on water, since it would be less likely to be damaged. His ideas were scorned, but he never lost faith in the hydro-aeroplane, and the Waterbird was a successful expression of that faith. It was a biplane with a single central float, generally similar to contemporary Curtiss aircraft.

No history of flying-boat development could be complete without adequate acknowledgment of Curtiss' great pioneering work.

Glenn Hammond Curtiss first made a name for himself in his home town of Hammondsport, N.Y., as a cyclist and motor cyclist. In 1904 he established a motor-cycle speed record which stood for several years. In that year he also made a three-wheeled road vehicle propelled by a crude airscrew which was driven by a small engine of his own design.

Curtiss had enjoyed a considerable amount of success with his lightweight engines, a fact which had not escaped the attention of the well-known American balloonist Thomas Scott Baldwin. In 1902 Baldwin sought Curtiss' assistance to obtain an engine for an airship he had begun to make. The ship was the *Californian Arrow* of 1904 which, with its Curtiss engine, was instantly successful. Baldwin went on to make no fewer than thirteen dirigibles, all Curtiss-powered, one of which was the U.S. Army's first airship: it was powered by a Curtiss engine, and was officially tested at Fort Myer, Virginia, on August 18th, 1908.

The success of Curtiss' airship engines had stimulated his interest in aviation, and in 1907 he had joined Dr. Alexander Graham Bell's Aerial Experiment Association as director of experiments. Their associates were Lt. Thomas E. Selfridge, Frederick W. Baldwin and J. A. D. McCurdy. Three of the four aircraft produced by the Association do not concern this narrative, but the aeroplane which was the third to be built was designed by Curtiss; it was completed in June 1908, and was consequently named *June Bug*. Powered by a 40 h.p. Curtiss V-8 engine, *June Bug* was remarkably successful.

Late in 1908 Curtiss became interested in the idea of an aircraft which could rise from and alight on water. He began to experiment with the *June Bug* airframe: crude pontoon floats replaced the wheels, and the aircraft was renamed *Loon*. Despite many attempts made in November 1908, *Loon* could not be persuaded to leave the waters of Lake Keuka: the floats were of the wrong shape, and the aircraft was underpowered.

The Aerial Experiment Association disbanded at the end of 1908; and on March 3rd, 1909 Glenn Curtiss formed a syndicate in company with A. M. Herring and Cortlandt Field Bishop. The syndicate established the Herring-Curtiss company, the first aero-

The Curtiss "America" for which an Atlantic crossing was planned.

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THE FELIXSTOWE FLYING-BOATS . . .

plane manufacturing firm in the U.S.A. It was short-lived, however, owing to litigation by the Wright brothers for alleged infringements of their Wright patents.

Curtiss continued his work on his own. He had not lost his interest in building a hydro-aeroplane, and finally he succeeded in taking off from the water at San Diego, California, on January 26th, 1911. The first U.S. Navy aeroplane was a Curtiss A-1 seaplane which first flew on July 1st, 1911. Like the original Curtiss seaplane, the A-1 had a large central float; lateral stability on the water was obtained by buoyancy cylinders under the lower wing-tips. On July 8th wheels were added to the Curtiss A-1; they could be raised or lowered in flight, and in this amphibious form the aircraft was known as *Triad*. On July 10th Glenn Curtiss made what must have been the first flight of its kind in history: he took off from the land, raised *Triad*'s wheels while in the air, and alighted on Lake Keuka.

The success of January 1911 had not been achieved without a great deal of hard work, for Curtiss had experimented with many types of floats and hydro-skis from November 1908 onwards. Having succeeded, he continued to develop the hydro-aeroplane, and to a man of his imagination it was a natural, though bold, step to develop the central float of the seaplane into a full-length hull which acted both as the aircraft fuselage and as a float. In doing so, Curtiss produced the world's first successful flying-boat, which made its first flight on January 12th, 1912.

This Curtiss boat had a simple, full-length hull of wooden construction, and was powered by a 60 h.p. engine which drove twin airscrews by a clutch and chain transmission. Apart from its ailerons, which were mounted in mid-gap, the Curtiss boat was of conventional appearance.

Again Curtiss did not stand still, and development of his flying-boats proceeded throughout 1912 and 1913. In 1913 he brought his latest boat to England; it was flown from Brighton beach by Mr. J. D. Cooper, who had learned to fly at the Curtiss school in America. The machine was housed in a hangar which had been put up by Mr. Magnus Volk to house seaplanes which had been giving exhibition flights at Brighton during the summer.

The exclusive British agency for the Curtiss flying-boat was acquired by the White and Thompson Co., Ltd., of Bognor, Sussex (which was to become, on October 4th, 1915, the Norman Thompson Flight Co., Ltd.).

Thus was John Porte brought into close contact with Curtiss products, for he had joined the White and Thompson company as test pilot in the autumn of 1913. Porte had remained with the British Deperdussin company until it broke up in August 1913, by which time he had acquired a reputation as a skilful and daring pilot. In the summer of 1913 he had been experimenting with a seaplane at Osea Island in Essex.

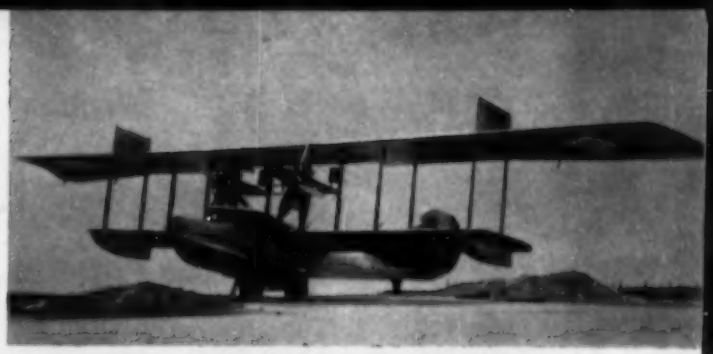
Porte's period of employment as the White and Thompson company's test pilot was brief, for in 1914 he went to America to join Glenn Curtiss. The great American designer had been commissioned by Rodman Wanamaker to produce a flying-boat capable of crossing the Atlantic; the aircraft was to be flown by Porte. Associated with Curtiss and Porte in the testing was Lt. John H. Towers of the U.S. Navy, who had first flown the Curtiss A-1 floatplane on July 6th, 1911, and had done much experimental flying with Curtiss hydro-aeroplanes throughout 1912.

Curtiss worked at record speed to complete the aircraft, which emerged in June 1914 as a handsome biplane, powered by two 90 h.p. Curtiss OX engines which drove pusher propellers. The power units were mounted in mid-gap, and there were two bays of interplane bracing outboard of each engine. The upper mainplane had long extensions which were braced by cables from king-posts, and it spanned 72ft. The hull was a boat-built structure with a single step and of fairly narrow beam; it was of wooden construction throughout, was planked overall with plywood, and embodied an enclosed cabin for its crew of two. The fin was a triangular surface of low aspect-ratio, and the rudder had a pleasing rounded outline; the tailplane was mounted high up on the fin.

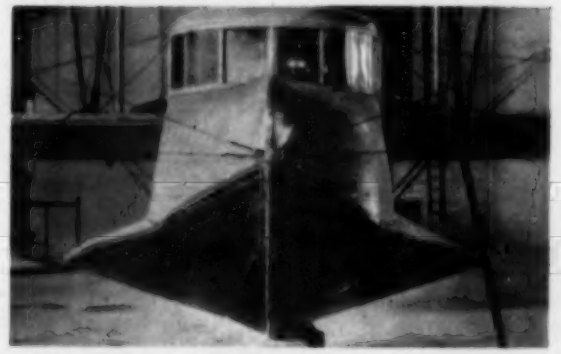
This Curtiss Atlantic contender was named *America*. It was tested on Lake Keuka and performed well. Unfortunately it proved to be underpowered when fully loaded, and Porte was unable to coax it off the water. Work began at once on its modification to take more powerful engines.

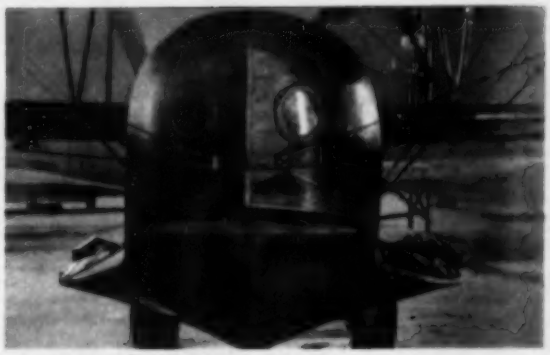
But events had moved fatefully on the other side of the ocean *America* was destined never to cross, by air at least. On the 28th of that same June in which the big flying-boat was launched, the Archduke Francis Ferdinand, heir to the throne of Austria, and his wife were assassinated in Sarajevo, the capital of Bosnia. The consequences of that tragedy are now history.

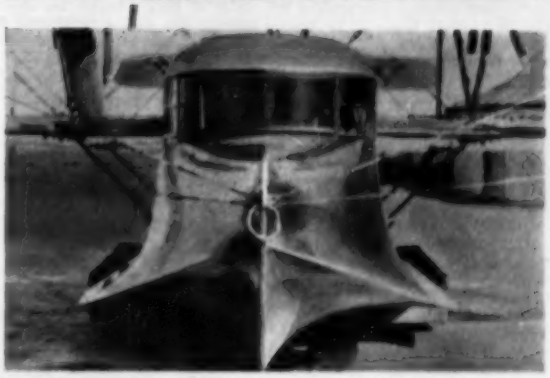
On the afternoon of Tuesday, August 4th, 1914, John Porte sailed for England, an England which by then was at war. On his arrival there he was at once accepted into the R.N.A.S., despite his disability, and before the end of August he was in command of the R.N.A.S. station at Hendon with the rank of squadron commander. Soon after his return Porte saw Captain (now Rear-

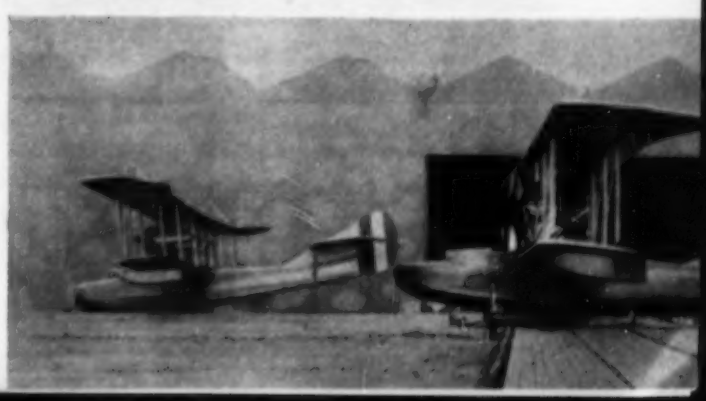


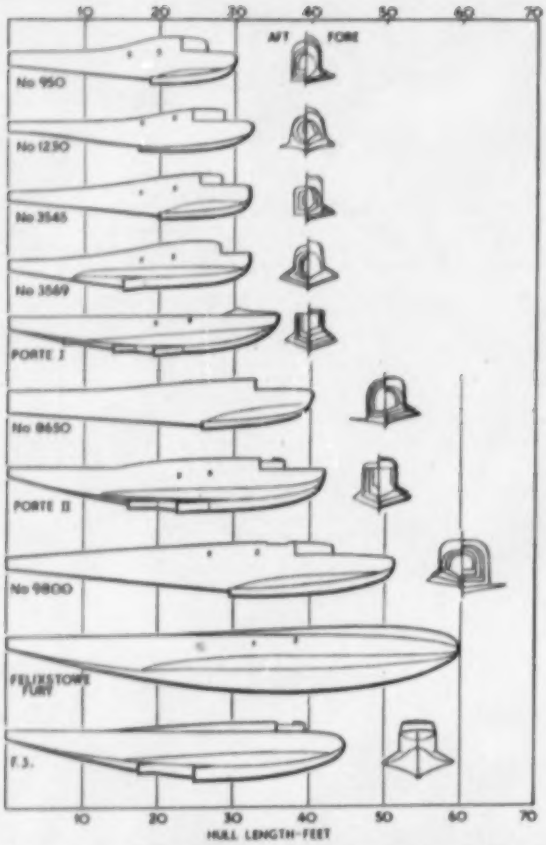
(Above) Standard Curtiss H.4. (Below, in descending order) Experimental hulls: No. 3545 (believed to be as modified by Porte); the "Incidence Boat"; No. 1231's Saunders-built hull; and an unknown experimental hull on an H.4; the boat on the right is a Porte Baby.











Hulls to the design of John Porte. No complete details are available on the section of the Fury's hull.

THE FELIXSTOWE FLYING-BOATS . . .

Admiral Sir) Murray Sueter, the Director of the Air Department of the Admiralty, and told him of the America flying-boat. Captain Sueter immediately recognized the value of such aircraft for the type of warfare likely to be waged around the shores of Britain. He obtained Admiralty permission to purchase two flying-boats of the America type: they were delivered in November 1914 and were given the official serial numbers 950 and 951. It seems probable that one of the two may have been the original *America* itself.

The two Curtiss boats were sent to Felixstowe, where they were tested extensively. They performed quite well, and an order was placed with the Curtiss company for a small batch of the type. In March 1915 a further order for 50 Curtiss flying-boats was placed; the aircraft were delivered late in 1915. They incorporated a number of modifications but their 100 h.p. Curtiss engines left much to be desired and had to be replaced, usually by two Anzani radials of 100 h.p. each, or occasionally by a pair of 110 h.p. Clerget rotaries. The official designation H.4 was allotted to the Curtiss America-type flying-boat.

Writing of the Curtiss H.4s in his book *The Spider Web*, Sqn. Cdr. T. D. Hallam, D.S.C., said: "These were comic machines, weighing well under two tons; with two comic engines giving, when they functioned, 180 horse-power; and comic control, being nose-heavy with engines on and tail-heavy in a glide. And the stout lads who tried impossible feats in them had usually to be towed back by annoyed destroyers."

Early in 1915, Porte was stationed at Felixstowe, where he flew the earlier Curtiss machines operationally. He therefore came quickly to understand their shortcomings, chief among which were poor hydroplaning characteristics, poor stability on the water, and a lack of seaworthiness. With the approval of Captain Sueter, Porte began a series of experiments aimed at producing a seaworthy and operationally useful flying-boat. In September 1915 he was given command of the Felixstowe air station.

The experiments with the Curtiss flying-boats began in the spring of 1915. The first hull to undergo test was that of the America flying-boat No. 950: this was a 30ft hull with a short forebody and a single step. Porte added side fins which ran fore-and-aft along the chines from a point two feet behind the bows to the step, and thereby provided a maximum beam over the fins of 8ft. With this hull No. 950 weighed 3,100 lb empty and 4,500 lb loaded, and was fairly successful; in rough weather, however, a good deal of water was shipped, since the short forebody did not give sufficient buoyancy forward. The original lifting tailplane was given negative camber to improve in-flight stability.

A new hull was built and was fitted to the Curtiss H.4 No. 1230. This was longer (32ft 7½in) and slightly narrower (7ft 9½in) than that of No. 950. The single step was directly under the rear spar of the lower wing, and the side fins were long; the underside of the tail portion of the hull was slightly concave in side elevation. This last feature proved to be a mistake, for it caused increased suction and made take-off difficult in calm weather. The hull was of lighter construction—it was in fact some 300 lb lighter than that of No. 950—but was not sufficiently robust and failed after several landings.

The next hull was fitted to the Curtiss H.4 No. 3545, and was generally similar to No. 950. This third hull was 32ft 4in in length, and its single step was 12ft 4in from the bows. Whereas on No. 950 the fore-and-aft angle (*i.e.*, the angle between the underside of the tail portion of the hull and the planing surface) had been 10 deg, on No. 3545 it was only 7 deg. This led to long take-off runs and high take-off speeds, for it was not possible to trim back to the optimum take-off angle and still hold up the tail sufficiently far to keep water drag down.

Thus it was established that, to provide adequate take-off trim, a flying-boat hull required a large fore-and-aft angle. Additionally, the experiments showed that hydroplaning performance was improved by having a flat-bottomed tail portion.

Having settled the design features which were fundamental to good take-off behaviour, Porte turned his attention to improving landing characteristics. At the same time he began to study means of increasing the strength of hulls without impairing their hydrodynamic efficiency.

All the hulls he had used up to that time had, like those of the standard Curtiss H.4, been boat-built structures in which a skin of wooden planking was applied to wooden frames. These frail boats had to be handled carefully, but never more than when alighting. In the majority of the breakages which inevitably occurred it was found that the hull failed at the step.

Porte's next experiment set out to determine whether a step was necessary, and this time the test vehicle was the Curtiss H.4 No. 3569. Again a boat-built hull was used; it was very similar to that of No. 3545, but had a completely new bottom. There was no step; the planing bottom had a sharper vee; and the tail was carried high, thanks to the sharper up-sweep of the bottom line of the tail portion of the hull. This hull never flew in its original form, for the available engine power was insufficient to lift it from the water.

A step was then added by the surprisingly simple, albeit obvious, expedient of applying it to the outside of the hull. (The steps of earlier hulls had been formed as integral parts of the structure.) This step was 16ft 10½in from the bows, and 5ft behind the aircraft's centre of gravity. The boat flew successfully at 4,200 lb loaded weight, but the rearward position of the step demanded a considerable physical effort by the pilot to lift the aircraft off the water; the step was therefore moved three feet forward. The sharper vee of the planing bottom made landing easy, with little or no shock at the moment of alighting.

Parenthetically, it should be noted that at about this time two other experimental flying-boats were flown at Felixstowe, but their connection with Porte's experiments is uncertain. The Anzani-powered Curtiss H.4 No. 1231 was tested with a beautiful hull built by S. E. Saunders, a single-step structure with a deeply-fluted planing bottom. Another machine, powered by two Clerget engines, had a deep, ugly hull with a blunt prow, and was known as the Incidence Boat.

During the experiments with the Curtiss America hulls, work had begun on the construction of a very large three-engined flying-boat which had been designed by John Porte. This aircraft was the largest ever built in Britain up to the time of its appearance: it seems to have been officially designated F.B.2, but was facetiously

The prototype Porte Baby with modified engine installation.

dubbed *Baby* or H.M.S. *Baby*—at that time the name Baby was frequently applied to small single-seaters.

The Porte Baby was obviously closely related to a large three-engined flying-boat, powered by three pusher engines, which was described as a Curtiss type in the 1917 edition (pp. 226b-227b) of Jane's *All the World's Aircraft*. The wing structures of the two boats appeared to be practically identical, but the engines of the Baby were differently disposed: only the central power unit drove a pusher airscrew, and the outboard engines were mounted as tractors. The hull of the Porte Baby, also, appeared to differ from that of the so-called Curtiss, particularly in the design of the afterbody.

The first Porte Baby was No. 9800. Its boat-built, plywood-covered hull was 56ft 10in long and 7ft wide; its maximum beam over side fins was 14ft, and it had a single step. Power was provided by three 250 h.p. Rolls-Royce engines of the type which was to become known as the Eagle; and the aircraft weighed 16,500 lb fully loaded. As on the smaller Curtiss America boats and the big three-pusher Curtiss, a glazed enclosure was provided for the pilots.

In its original form the Baby's hull had a relatively short fore-body, and when tested the boat was found to wallow in a following sea. The water performance was greatly improved by lengthening the bows by three feet, and the Baby could leave the water fully loaded in about 35 sec. It was rather underpowered with only 750 h.p.; the maximum speed was 68 kt (78 m.p.h.), and 3,000ft was reached in 20 minutes.

The Porte Baby was put into production on a very small scale: twenty were ordered (numbered 9801-9820) and at least ten were completed by May, Harden and May, of Southampton Water, a subsidiary of the Aircraft Manufacturing Co. It is believed that Nos. 9811-9820 were subsequently cancelled, but some of these later hulls may have been made.

Most references quote three Rolls-Royce engines as the standard power installation, but some at least of the Babies had a 260 h.p. Green as the central engine. The production Babies had a modified form of installation for the outboard engines. Whereas No. 9800 originally had a diamond-shaped configuration of struts at the rear of the engine mountings, the later installation had only a single plain interplane strut. Ultimately No. 9800 also conformed to this arrangement. Performance was improved by the installation of more powerful marks of Rolls-Royce Eagle engine, and the Baby which underwent official performance trials in December 1917 and March 1918 had three Eagle VIIIs. Improved radiators, generally similar to those of the later F-boats, were fitted to some Babies.

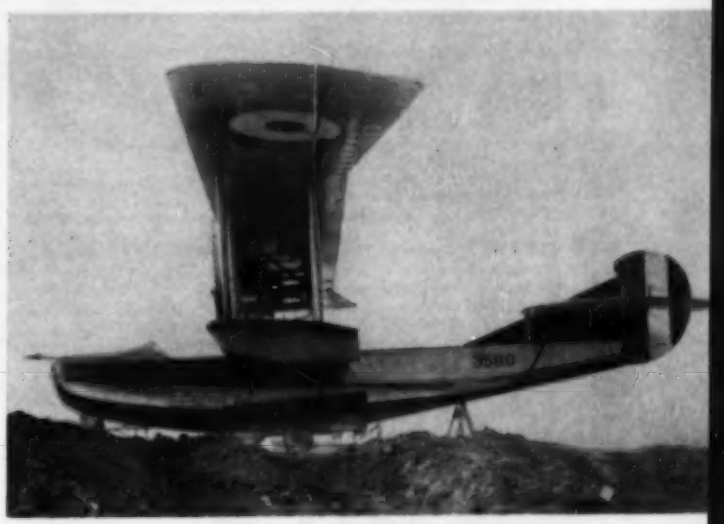
The Porte Baby flying-boats were flown operationally on oversea patrols from the R.N.A.S. stations at Felixstowe and Killingholme. When attacked by enemy seaplanes they were too large and slow to be able to give a good account of themselves in combat; moreover, the design of the boat did not lend itself to the effective use of defensive weapons. Some had a Scarff ring-mounting on a cockpit in the bows, but in the main reliance was placed on guns fired through windows.

Just after 4 p.m. on October 1st, 1917, the Baby flown by Flt. Cdr. N. Sholto Douglas and F/L. B. D. Hobbs was attacked by two enemy seaplanes and a landplane near the North Hinder Light Vessel, off the Dutch coast. The other members of the Baby's crew were Lt. M. W. W. Cross, R.N.V.R. (engineer), Sub-Lt. H. O. Fry (armament officer), and Air Mechanics C. Spikings and H. M. Davies. During the unequal combat Hobbs evaded the enemy's attacks for 20 minutes, and a hot fire was maintained by the flying-boat's gunners. The port and centre engines were shot about and stopped, and the Baby was forced to alight on the sea. During the fight A/M. Spikings continued to fire at the enemy after the engines near him were on fire and he had been scalded. Thanks to his gallantry, the enemy machines were prevented from closing effectively with the Porte boat, but once it was on the water they machine-gunned it as it lay helpless, and wounded A/M. Davies.

Nevertheless, the Baby's crew managed to repair the engines sufficiently to enable the boat to taxi slowly westwards. Despite his badly burned hands Spikings worked for several hours during the night on the engines. After a long and difficult journey, the craft managed to reach Sizewell Gap, on the Suffolk coast, by 1.30 a.m. on October 2nd. From there it was towed back to Felixstowe. After this near-disaster, the Porte Babies were never again used to patrol areas in which they would be likely to be attacked.

One of the Babies was used in experiments with torpedoes: it flew in April 1916 with two 14in torpedoes under its lower wings, but it is uncertain whether any attempt to drop the missiles was made. The prototype Baby, No. 9800, had a six-pounder Davis non-recoil gun mounted experimentally on its bows, probably as an anti-submarine weapon, for it would have been over-optimistic to consider the Porte Baby as an anti-Zeppelin aircraft.

From the historical point of view, the most interesting experiment in which a Porte Baby participated was the remarkable "composite" flight which was made in May 1916. This was a bold attempt to combine the speed and manœuvrability of a single-seat scout with the long range of a large flying-boat; the object of the experiment was to provide an effective anti-Zeppelin weapon. A Bristol Scout C (No. 3028, one of those belonging to the seaplane carrier H.M.S. *Vindex*) was placed on the upper wing of a Porte Baby with its undercarriage just in front of the leading-edge. The Scout's wheels rested in crutches which were braced to the engine bearers of the flying-boat's central power unit, and its tail skid was held by a quick-release catch which was operated by the pilot of the Scout.



The aircraft with the Porte I hull was designated F.1 and became first of the line. (Above) The Porte Baby and Bristol Scout C "composite."

On May 17th, 1916 the Baby took off from Felixstowe with the Scout in place. The flying-boat was flown by Sqn. Cdr. Porte, the Bristol by F/L. M. J. Day. When the combination had reached 1,000ft Day switched on his engine and climbed away. Despite this success, however, the experiment was never repeated.

It appears that the Porte Baby was long-lived, for two examples of the type were still on charge with the R.A.F. at the end of October 1918.

No attempt had been made to develop the design of the Baby, however. Before the production Babies appeared—possibly even before No. 9800 itself was completed—John Porte tested a completely new type of hull on the Curtiss H.4 No. 3580. This hull was named the Porte I, and the modified H.4 to which it was fitted was the true progenitor of the line of Felixstowe F-boats. The new hull was built at Felixstowe air station, and in its ultimate form fulfilled Porte's desire to produce a hull which combined structural strength with hydrodynamic efficiency.

The chief interest of the Porte I hull lay in its structure. Basically it differed little from the fuselages of most contemporary landplanes, for it consisted of a sturdy cross-braced box-girder to which were added a vee-shaped planing bottom and side fins. From bows to sternpost the hull was 36ft 2in long, and its maximum beam was 8ft; the side fins were about 25ft long. The top longerons of the basic structure were quite straight in side elevation; this raised the tail higher than that of any of the earlier experimental machines and gave a fore-and-aft angle of 18 degrees. The keel line was a smooth curve from stem to stern. Unlike its predecessors, the Porte I had open cockpits.

THE FELIXSTOWE FLYING-BOATS . . .

In its original form the hull had only one step, which was situated below the rear spar of the lower wings. It was found that take-off was hampered by tail drag, and a second step was fitted about 12ft behind the first. This made take-off possible, but at a lower weight than earlier hulls. A third step was added, at a distance of 5ft 4in behind the front step, and the Porte I was then able to take off at the same loaded weight as its predecessors. In this form, the hull had excellet landing and take-off characteristics, and its full, flared bows prevented the shipping of water.

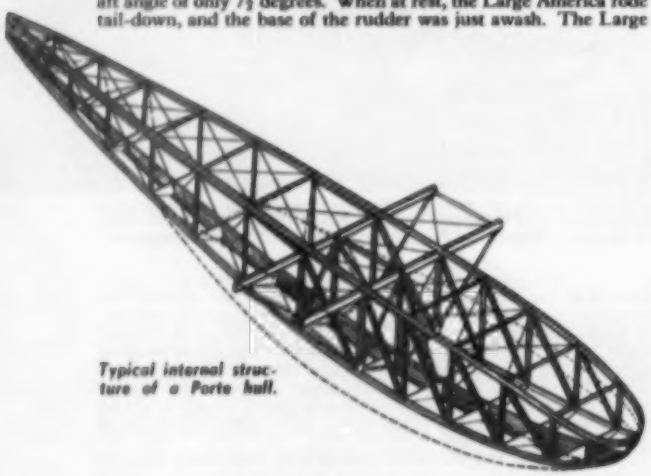
The performance of the aircraft must have been assisted considerably by its power installation: it had two 150 h.p. Hispano-Suiza engines driving tractor airscrews. The wings and tail unit were standard Curtiss H.4 components.

The aircraft with the Porte I hull was named F.1, a designation which established it as the first of the great line of flying-boats which were designed at Felixstowe, and which were to play a substantial part in the achievement of ultimate victory.

At an early stage of the war Porte had realized that the Curtiss H.4 was inadequate for long-range patrol work. He therefore asked Glenn Curtiss to develop a larger flying-boat with greater range and load-carrying capabilities. An official order for fifty such boats was placed before the end of 1915, and the first arrived in England in July 1916.

The new Curtiss flying-boats were known as Large Americas, and after their advent the H.4s became Small Americas. The Large America type, as delivered, had two Curtiss engines of 160 h.p. each; in this form it was officially designated Curtiss H.8. The Curtiss units proved to be unsatisfactory and were replaced by two 250 h.p. Rolls-Royce engines. Thus modified, the aircraft was designated Curtiss H.12 and did much good work.

But the hulls of the big new Curtisses were still not completely satisfactory for service in the sea conditions around Britain. Like the hulls of the Small Americas, they were single-step boat-built structures; 40ft long, 11ft at maximum beam, and with a fore-and-aft angle of only 7½ degrees. When at rest, the Large America rode tail-down, and the base of the rudder was just awash. The Large

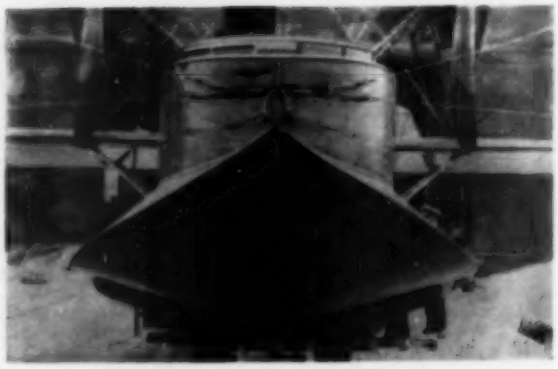


Typical internal structure of a Porte hull.

America hull, like its predecessors, was structurally weak, a disadvantage which was not improved by somewhat inferior workmanship: the structure was liable to fail at the step, and pilots had to exercise all their skill to avoid damage at take-off and touch-down. The risk of damage was present even in a slight sea, and the operational effectiveness of the aircraft was therefore limited. Furthermore, the shape and construction of the hull made it difficult to fit machine-guns in good defensive positions: no gun could fire directly downwards, and the rear gun's field of fire was obstructed by the tail unit.

Encouraged by the excellent results obtained with the Porte I hull, John Porte decided to build a hull of similar design for the Curtiss H.12 superstructure. To determine the characteristics of the original Curtiss hull, he conducted a series of tests with the first of the big Curtiss boats, No. 8650, which still had its Curtiss engines when Porte set to work upon it. In its underpowered state, the boat would not take off at a loaded weight of 8,700 lb. After the substitution of two 250 h.p. Rolls-Royce engines, the H.12 took off with difficulty, for the hull's short forebody did not give sufficient buoyancy forward and it had a pronounced hump speed of 18 kt.

The new hull for the Large America was known as the Porte II. It measured 42ft 2in from stem to sternpost and had two steps, one directly under the rear spar of the wings, the other 6ft 5in farther aft. Porte II had the same maximum beam as the Curtiss H.12



The boat with the Porte II hull, designated F.2.

hull, but its fore-and-aft angle was 20 deg, and the side fins were about 30ft long. On test its performance was greatly superior to that of the Curtiss hull. With the Porte II hull the aircraft took off at 10,500 lb loaded weight after accelerating quickly and smoothly to take-off speed.

The flying-boat with the Porte II hull was designated F.2. It had the mainplanes of a Curtiss H.12, but a new tail unit was fitted.

The structure of the Porte II hull was the prototype for all the succeeding Felixstowe boats, and it changed very little in its essentials throughout the war. The four wooden longerons and spacers formed a box-girder, the sides being "N" girders forward of the spar; all other cross-bracing was by means of wires or tie-rods. The spars of the lower centre-section were integral members of the fuselage. The bottom longerons were spaced by transverse "floors" of solid mahogany which were vee-shaped and formed the central planing bottom. These floors were notched out for two-thirds of their depth to fit over the solid keelson, which was correspondingly notched for one-third of its depth; the keelson ran as a continuous member from stem to stern.

The side fins were built on to the outside of the hull. Continuous timbers of rock elm ran from chine to chine beside and between the mahogany floors; the planking was attached to these timbers. The planking was double diagonal, consisting of an inner ply of ¼in-thick cedar and an outer ply of ⅛in mahogany, the two being separated by a layer of varnished fabric. On the early F-boats the bottom planking was continuous from stem to stern with the step planking superimposed, and the planking was five inches in width. Three-ply planking was applied to the fin tops and to the sides of the hull as far aft as the rear spar, abaft which point the sides were fabric-covered with a solid mahogany washboard one foot deep along the lower longerons. The top decking was planked in front of the cockpit; the rear portion was fabric-covered.

Porte had intended only to produce a flying-boat which would operate from sheltered harbours such as Harwich, but the demands of war found the F-boats working from exposed waters, often with lengthy periods at their moorings. Such conditions proved too much for the hull covering: the 5in planks warped, water seeped into the joints in the three-ply covering of the fin tops and hull sides, and the mahogany washboards split and the fabric rotted. Narrower planks had to be fitted, double-diagonal planking of cedar and mahogany was applied to the fin tops, and the sides were either planked with a single layer or covered with fabric and planked with "Consuta." Several structural modifications had also to be made as operational experience was gained. In particular the planking of the steps had to be modified, for in some instances they had been wrenched off the hull bottom.

Not only did the F.2 flying-boat prove to be superior to the Curtiss H.12 in strength and seaworthiness, but the fundamentally simple structure of its hull design made it an excellent production proposition, for it could be built by firms which had no experience of boat-building. The F.2 design was therefore ordered into production in 1917. This was a well-deserved acknowledgment of the work of John Porte who, in the words of Sqn. Cdr. Hallam, "carried out his plans with a scratch collection of draughtsmen, few with any real knowledge of engineering; with boat-builders and carpenters he had trained himself; and he only obtained the necessary materials by masterly wangling. He frequently started a new boat and then asked the authorities for the grudged permission. But in all things connected with the building of flying-boats his insight amounted to genius, and the different types of boats kept getting themselves born."

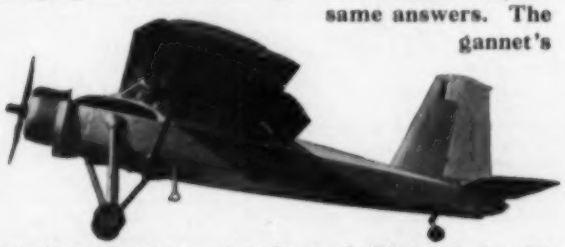
Porte's Chief Technical Officer was Lt. (later Maj.) J. D. Rennie, who assisted considerably in the work connected with the evolution of the F-boats.

(To be continued)

Problems of flight

WING FLAPS

Tiny extemporised runways, heavy loads — this combination is often imposed by modern business and modern war. To deal with it man has devised aircraft with very slow stalling speeds, achieved by means of leading-edge slats and trailing-edge flaps. Nature, in large cliff-dwelling birds like the gannet, long ago faced the same problem — and found the same answers. The gannet's



six-foot wing-span gives it nearly 50 m.p.h. in still air. But it nests in remote, craggy, far-northern cliffs, in crowded colonies of up to 10,000 pairs. This means that with all its size, weight and speed it must land on a sixpence. When it comes in to land — upwind whenever possible — it spreads its tail and large webbed feet wide to act as airbrakes. At the same time the secondary wing-feathers are pressed down, forming a broad flap at the trailing edge. The bird loses flying speed sharply. At this point a tuft of feathers — the alula or "bastard plume" — is extended from the leading edge. It has exactly the same effect on stalling characteristics as the leading-edge slats of an aircraft: at low flying-speeds it controls the airflow over the

aerofoil at a large angle of attack, and so delays the moment of stall until the bird is practically motionless.

Precisely the same method makes possible the astonishingly low stalling speed — 38 m.p.h. — of the Prestwick Pioneer, which can land in as little as 50 yards, and it is now being applied also to a 16-passenger twin engined version of the Pioneer. So man has solved yet another of his aeronautical problems with a technique that Nature has used for countless ages.

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1303—30A/1	Gear Wheel (Cam Shaft)
1303—74	Gear Box
1303—75	Adaptor, Gear Box
1304—9/1	Joint
1304—11	Sleeve—Push Rod, Rubber
1304—15	Ring
1306—5/1	Bush, Oil Pump
1306—45	Washer
1306—53	Washer
1403—4	Joint
1403—12/1	Clamp
1406—4/2	Gear Wheel
1406—16A	Washer
1406—40/2	Washer
1412—37A	Lever
1412—698	Bell Crank
1412—83A	Cam
1900—49	Bearing
1900—135	Bolt
1900—87	Stud
1901—17	Washer, Link
1902—2	Washer
1902—3	Head, Cylinder
1902—23A	Valve, Exhaust
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PNEUMATIC CONTROL

—*for Turbojets and Ramjets: a New System by Solar*

THE use of pneumatic pressure ratios as control parameters for turbojet and ramjet engine cycles was described in a lecture by Mr. Wendell E. Reed before the Society of Automotive Engineers in Los Angeles recently. With the title *A New Approach to Turbojet and Ramjet Engine Control*, the paper described the development by the Solar Aircraft Company (of which Mr. Reed is project engineer) of a simplified computing element known as the Microjet control.

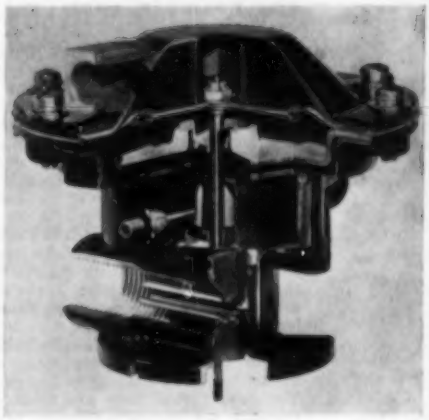
In his introduction Mr. Reed pointed out that, in the Mach 2.5 aircraft of 1960 which were on the drawing-boards today, the pilot would have to endure a temperature of 450 deg F, were the machine not equipped with an elaborate refrigeration system. At three times the speed of sound the lowest air temperature anywhere in the aircraft was 650 deg F. The engine and associated control components, however, must be capable of operating at much higher temperatures—between 800 and 1,000 deg F.

By contrast, many of the available electronic components required for control systems were limited to operating temperatures of less than 250 deg F. Even highly developed electromechanical components, such as electric motors and solenoids, were marginal about 500 deg F. At this temperature, the best known hydraulic fluids began to decompose, and the most advanced types of plastic materials used for seals became unsatisfactory at more than 600 deg F.

To overcome the disadvantages of electronic and hydraulic equipment at high temperatures, the use of pneumatics was a possible solution. Turbojet and ramjet engines were basically air-pressure producing machines and small amounts of leakage presented no problem and certainly no fire hazard. Thus, the design of seals was less critical and not limited to the use of resilient materials which possessed a temperature limitation. Another advantage of pneumatics was that the need for storage tanks, pumps and power supplies was eliminated and, so long as the engine was operating, the source of fluid in the pneumatic system was assured.

The substitution of compressed air in place of electric power or hydraulic fluid as the operating medium for a control system, the lecturer continued, did not, however, permit the full realization of the potential advantages of an all-pneumatic control system. Not only the muscles, or actuating elements, but also the brains, or computing elements, of the system must undergo considerable face-lifting in exploiting the conversion to pneumatics. It was conventional practice, for example, in controlling the variable-area jet nozzle of a turbojet, to utilize turbine-inlet temperature or turbine-discharge temperature as the primary control parameter. The selection of this parameter demanded the use of electronics in the system. The thermocouples which were used to measure the temperature created a weak electrical signal, which must be amplified electronically before it became usable.

Although non-electric methods of temperature measurement were available, these were eliminated from practical consideration on the basis of response time. The benefits of pneumatics could best be realized if pneumatic control parameters were used in place of temperature parameters. It was significant that the engine-matching characteristics could be controlled using three engine pressure ratios. If the r.p.m. and two pressure ratios were known, the actual turbine-inlet temperature could be controlled. It was possible, merely by sensing pressure-ratio parameters, to control the variable-area jet nozzle, afterburner fuel flow, engine fuel, compressor air bleed, variable inlet guide vanes, and variable inlet geometry, in order to maintain the engine variables within the prescribed mechanical and thermodynamic requirements of a high-performance engine.



Microjet control in part section.

The operating principle of the Microjet pneumatic computing control was shown in the illustration (Fig. 1). The primary purpose of the device was to provide a mechanical-displacement output signal which indicated the magnitude of the ratio between the two pressures. One pressure was applied to the upper side of a flexible diaphragm, and the other pressure was used to generate a controlled reference pressure which was applied to the lower sides of the diaphragm. This reference pressure was generated by bleed air, generally from the compressor discharge, through a series of two orifices, the area of one of which was controlled by a tapered portion of a needle attached to the diaphragm.

In operation, the flexible diaphragm, which was substantially free to move in response to pressure differences, operated in such a manner as to maintain the reference pressures exactly equal to the pressure applied above the diaphragm. An increase in the upper pressure resulted in a downward movement of the diaphragm which caused a corresponding decrease in the area of the second orifice. This raised the reference pressure and retarded the movement of the diaphragm until equilibrium was re-established and the diaphragm displaced to a new position at which the two pressures were equal. This position was directly related to the new value of the ratio between the two applied pressures.

Comparing the Microjet pressure-ratio control with the conventional pressure-ratio sensing device, the main advantages of the former arose from the latter's use of precision bellows to measure differential pressures. The requirements of the conventional system were for precision-evacuated bellows, precision temperature-compensated reference springs, complicated and precision dividing linkage, delicate instrument-type construction and skilled servicing; the output function was non-linear unless compensated by additional cams. The Microjet-type control, however, was relatively simple and more versatile. It used a single non-linear diaphragm, the size of which was not critical; it was easily calibrated and adjusted; there was no friction or wearing parts; construction was simple yet rugged; the contoured needle provided any type of output function; and the device was easily serviced by any trained technician.

A typical application of a Microjet pressure-ratio control was the variable-area jet nozzle control shown in the diagram (Fig. 2). Early turbojets had been designed for use with a fixed jet nozzle, resulting in their operating essentially at a fixed turbine pressure ratio. Later it became necessary to provide a variable-area jet nozzle to compensate for the increased volume of exhaust gas resulting from afterburner combustion, and to maintain "balanced cycle" control, i.e. to maintain the constant turbine-pressure ratio for which the engine and control system had been designed.

It was for this purpose, in conjunction with an afterburner development project, that the Microjet principle had been initially conceived at the Solar Company—after consideration of virtually every other possible means of obtaining the required response and reliability. In 1949, a Microjet control was first applied to a Westinghouse J35-WE-34 engine and flight-tested in a Chance Vought XF7U aircraft.

The system (Fig. 2) consisted of a Microjet pressure-ratio sensing element, the output needle of which controlled an integrating servo valve and actuator combination to move the jet nozzle. The control sensed two engine pressures, the turbine discharge pressure applied to the upper side of the diaphragm

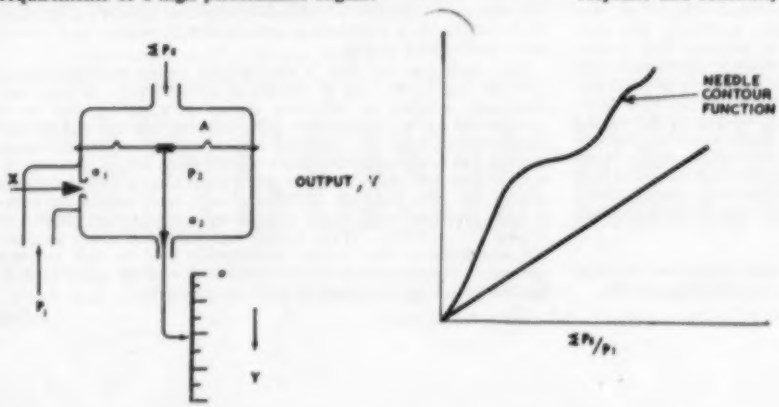


Fig. 1. The operating principle:—

$$Y = f\left[f_X(x) \cdot f_N\left(\frac{\Sigma P_t}{P_1}\right)\right]$$

PNEUMATIC CONTROL . . .

and the compressor discharge pressure which was applied to the series of two orifices to produce an intermediate reference pressure on the lower side of the diaphragm. In operation, a decrease in turbine pressure ratio (for example, such as would be caused by light-off of the afterburner) caused the turbine discharge pressure to rise, displacing the diaphragm downward. As the contoured needle decreased the size of the second orifice, it raised the reference pressure until the diaphragm reached a new equilibrium position corresponding to the error in turbine pressure ratio. As the needle moved downward, it operated the pneumatic servo valve which bled compressor-discharge air to one side of the pneumatic actuator, moving the jet nozzle in the open direction. This reduced the turbine-discharge pressure, restoring it towards its original value. Conversely, should the afterburner flame be extinguished, the sudden increase in turbine pressure ratio would cause the Microjet control to return the jet nozzle to the closed position.

With the succeeding generation of turbojet engines, the afterburner had been adapted as an integral part of the engine design. The next logical step was to utilize the variable-jet nozzle to improve the non-afterburning performance of the engine by maintaining the maximum permissible turbine-blade temperature. This had resulted in a requirement for a constant turbine-inlet temperature control. Since it had proved impractical to utilize thermocouples in the high-temperature zone ahead of the turbine, however, the use of turbine discharge temperature was accepted as a compromise substitution.

In order to maintain constant turbine discharge temperature at constant military r.p.m., it was necessary to increase the turbine pressure ratio by opening the jet nozzle as the compressor inlet temperature rose. In initial attempts to use the Microjet control to maintain constant temperature, the turbine pressure-ratio setting was biased as a function of compressor inlet temperature by utilizing a temperature-compensating element. This was not considered the most desirable solution, because of the slow rate of response of this type of temperature element.

The system was then re-evaluated on the basis of substituting other engine parameters for the compressor-inlet temperature. With the engine operating at constant military r.p.m., the compressor ratio varied almost as a linear function of the compressor inlet temperature. Therefore, by establishing a scheduled relationship between turbine pressure ratio and compressor pressure ratio, a constant turbine-discharge-temperature operation could be achieved.

Repeated flight-tests to altitudes in excess of 50,000ft, however, had indicated that still another factor had to be considered. Above 40,000ft, the decreased density of the air had a marked effect on the efficiency of the engine compressor, as a result of a wide variation in the value of Reynolds number. As compressor efficiency decreased at high altitude, relatively more work was required to turn the compressor. If constant turbine discharge temperature was to be maintained, this additional work could be obtained only by increasing the turbine pressure ratio by opening the jet nozzle slightly to hold the temperature constant.

In the previous examples, the selection of schedules had been made on the basis of close linear approximations. Not all schedules, however, could be reduced to this degree of simplicity and high pressure-ratio engines, in particular, tended to have greater non-linear characteristics. Furthermore, the modern nozzle-area control must provide not only constant temperature at military r.p.m., but ideally must also provide an appropriate nozzle-area for cruise operation and must maintain a pre-selected nozzle position during engine acceleration. By combining two Microjet elements into a single control, this type of non-linear schedule could be achieved.

This modified control consisted simply of two units combined into one. The primary unit sensed turbine pressure ratio and the secondary unit sensed compressor pressure ratio. The output needle of the secondary unit changed the position of a contoured element in the first orifice of the primary unit, thus biasing the turbine pressure-ratio setting as a function of compressor pressure ratio.

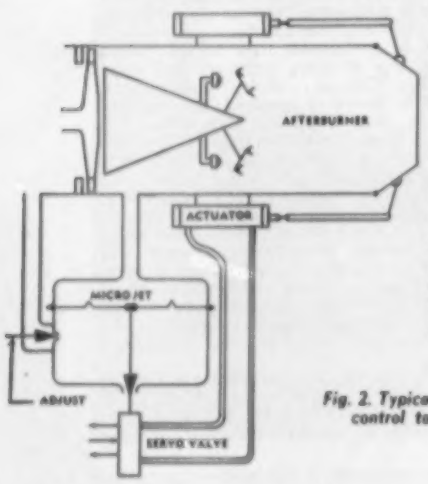


Fig. 2. Typical application of the Microjet control to a variable-area nozzle.

If the taper of the needle of the basic Microjet control were reversed a unique characteristic was achieved. With this configuration, the diaphragm assembly became unstable and snapped to either stop, depending on pressure-ratio level. Thus, whereas the basic unit normally produced an output signal that was a continuous proportional function of the error, the reference taper introduced a discontinuous characteristic pneumatically analogous to the action of the simple toggle-switch. This type of control was used with two-position jet nozzles where it was desired to establish and maintain the jet nozzle in the full-open position when the afterburner ignited, and to return it to the closed position when the afterburner was extinguished.

Extracts from the lecturer's detailed description of the Microjet control include:—

Use as Net Thrust Indicator. A compound Microjet is used wherein the primary unit senses turbine-presure ratio and the secondary unit senses compressor-pressure ratio. By appropriate shaping of the contoured needle, and operating the primary Microjet unit with both orifices choked, the quotient of these two parameters is computed pneumatically such that the output displacement of the primary unit is a function only of the engine pressure-ratio, which is itself a function of thrust.

Airflow Requirement. Standard units generally require less than 0.05 lb/sec at sea-level conditions, or less than 0.05 per cent of the engine airflow.

Insensitivity to Dirt. Service experience on over 2,000 Microjet controls has indicated that the units are relatively free from malfunction caused by dirt or impurities in the air supply . . . The heavier particles are carried past the compressor discharge opening by the high-velocity airstream and most of the smaller particles are separated by centrifugal action as a result of the design of the housing. Furthermore, the orifices are large enough so that blocking is virtually impossible.

Permissible Operating Temperatures. Military environment qualification tests have been successfully completed in an ambient temperature of 350 deg F, using compressor discharge air at 925 deg F. Other units have been operated successfully at ambient temperatures as high as 600 deg F . . . The operating temperature limit is determined only by the physical properties of the plastic diaphragm material. Current research into new types of material and new mechanical configurations for the diaphragm promise to eliminate altogether the limitations caused by operating temperature.

Accuracy. One of the design considerations contributing to the high degree of accuracy of the control is that large diaphragm areas—of the order of 5 and 6 sq in—are generally selected, so that signal actuating forces are available even at high-altitude operating conditions. Relatively large displacements of the order of 0.125 to 0.5in are used, so that inaccuracies due to manufacturing tolerances are minimized. An accuracy within approximately 0.3 per cent is achieved over a wide range of altitude operation.

Afterburner Light-Off and Blow-Out Detection. In some of the current production engines equipped with conventional electronic temperature-sensing variable-nozzle controls, the slow response of the thermocouples has created problems associated with the ignition of the afterburner . . . Turbine pressure ratio, on the other hand, changes instantaneously when the afterburner ignites and, as a result, the Microjet control is used in several such applications to initiate rapid opening or closing of the nozzle.

Overspeed Control. In another application of the above detector, Microjet control is used for preventing over-speed in a two-spool engine, by reducing engine fuel flow when a sudden change in turbine-pressure ratio indicates that afterburner blow-out has occurred.

Jet-Nozzle Control. The use of the Microjet principle for maintaining constant turbine inlet temperature by controlling the variable jet nozzle has already been successfully demonstrated in ground tests, altitude tank tests, and actual flight-tests. The use of pressure ratio for fully-variable control of the jet nozzle is being given serious consideration by many of the major engine manufacturers because of the significant reduction of weight, increase in reliability, and faster response.

Turning to the application of the Microjet control to fuel metering for ramjets and afterburners, the lecturer said that this was currently the subject of an extensive development programme. The basic fuel-controls in each case were quite similar, the primary purpose being to establish and maintain a basic fuel-schedule that was at least roughly proportional to engine airflow. For the ramjet, this fuel schedule was required mainly for ignition, the schedule being trimmed or over-ridden thereafter by a shock-wave positioning control.

The control of fuel flow in the turbojet engine was much more difficult than in the case of ramjets or afterburners. It was conventional practice to schedule engine acceleration fuel as a function of r.p.m., compressor inlet temperature and compressor discharge pressure. In the interest of reducing compressor-surge margin and eliminating the effect of variations in fuel characteristics, studies had been made by the Solar Company to determine whether a new concept, utilizing closed-loop control or compressor pressure ratio, might provide an answer to the control of engine acceleration. These studies had indicated many interesting possibilities—that engine acceleration fuel as well as inlet guide-vane position and compressor-bleed airflow could be controlled by the use of pressure-ratio parameters.

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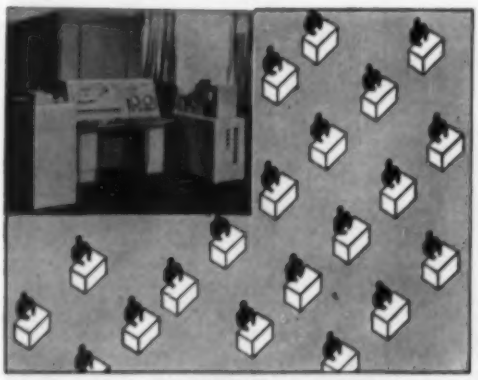

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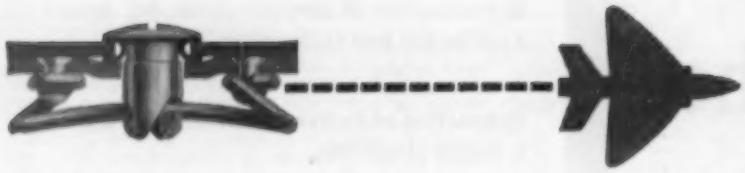

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CORRESPONDENCE

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"The Epoch of Air Power"

From Marshal of the Royal Air Force Sir John C. Slessor.

WOULD you allow me to comment on one sentence of your report in the issue of November 18th on the discussion after the Sir George Cayley Memorial Lecture, in which I am quoted as saying "certainly, of course, in time the front-line strength of air power would be entirely 'unmanned' "?

This, I think, gives an impression more definite than I intended to convey. It may be that in a future which is probably not as near as many people think the strategic bomber will give way to the long-range ballistic rocket, and the home-defence fighter to the ground-controlled guided missile.

But the push-button age is not just round the corner. Air power must preserve its flexibility, and it is too early to assume that even in a push-button age there will be no place for the manned bomber or fighter. In the tactical, maritime and transport roles, I do not think the front line of our air power will ever be unmanned—anyway, in any foreseeable future.

I must apologise for giving a misleading impression, which it is sometimes easy to do in the thrust and parry of discussion after a lecture.

London, W.1. J. C. SLESSOR, M.R.A.F.

Supersonic Bale-outs

IS one to assume that the news that a Hunter pilot had successfully baled out at supersonic speed was released to the Press by the Air Ministry? If so, why was the Ministry apparently unaware that at least one, and probably two, American pilots had ejected at supersonic speeds and survived the ordeal? So far as I know, no reference was made in British newspapers to the American escapes, one involving a Grumman Cougar and the other a North American F-100.

One is led to infer that the Air Forces concerned are slow to exchange information on such incidents. Surely this is wrong. There is nothing to be lost, and a great deal to be gained, from an international sharing of all experiences yielding data on problems of survival at high speeds and altitudes. Publication of such data in the aeronautical Press (subject to normal security regulations) is also to be recommended, as a means of ensuring that survival information reaches squadron aircrews without delay, instead of filtering slowly through "official channels."

London, W.1. ROGER BAKER.

Helicopter Rotor Practice

I HAVE now read Mr. Payne's valuable and interesting paper [mentioned in his letter in *Flight* for November 11th] entitled *The Stiff Hinged Helicopter Rotor* and have come to the conclusion that we are both after exactly the same thing.

We are agreed that the way to get the best out of a rotor which is operating in asymmetric flow is to load it asymmetrically and that, to do this, one must have a rotor arrangement which is capable of transmitting moments to and from the remainder of the helicopter.

We are also agreed that this same ability to transmit moments is desirable in order to achieve stability in hovering flight and I personally believe that, in allowing a forward c.g. offset, it will produce static stability in forward flight.

The only point at which we are at variance is the engineering method to be adopted. Mr. Payne wants a rotor blade which has a "soft" point somewhere near the root where the desired elastic stiffness is superimposed upon a mechanical hinge by means of, say, a torsion bar. I want a blade in which the desired elastic stiffness is provided by the blade itself in bending.

Mr. Payne's method certainly makes the mathematical analysis easier; in fact, my colleagues used the analogy of bending at a point in order to predict the behaviour of a hingeless rotor; he is also quite right in saying that the degree of stiffness required is not high. It is dependent, of course, upon the degree of c.g. offset required.

So far as I can see, the only "quarrel" I have with Mr. Payne's thesis is over his reference to rigid rotors. Of course a rigid rotor is structurally impossible; there is no such thing as a rigid rotor except in theory. I have certainly never termed my rotor "rigid," it is a hingeless rotor in which the differential lift and drag loads are taken in bending.

I believe that it is necessary to improve the fatigue life of helicopter rotors and that the way to do this is to make them into smooth, continuous structural members without joints and with no sudden changes of section, and to keep the operating stresses below the levels required for long life.

The introduction of a mechanical hinge in a blade produces all the requisite ingredients for fatigue failure. In addition, no journal can be designed economically for long life if it is subjected to high radial loads coupled with a very small angular travel; it merely becomes a "Brinelling" machine. In any case, the introduction of a hinge, whether "stiff" or "loose," does not prevent the blade from being subjected to comparatively large bending stresses along its length due to variations in flow distribution across the rotor disc.

However, I agree most emphatically with Mr. Payne that his method can readily be applied to existing articulated rotors and that flight experience could be gained this way with little trouble.

With regard to scale effect on hingeless rotors, it seems to me that if disc loading, static margin (stability) and number of blades are kept constant, then the bending moment at the blade roots will vary as the all-up weight to the power of three over two. Since, however, larger helicopters are likely to have several engines, a larger number of blades can conveniently be introduced. Both these factors will tend to reduce the adverse growth in blade root material weight and I have no doubt that, as with fixed wings, we shall find that blade weight will turn out to be approximately a constant percentage of all-up weight in a given performance bracket.

I regret that I am not in a position to publish any work on hingeless rotors at the present time, but I am gratified to see the most valuable contributions being made by Mr. Payne and look forward keenly to seeing his ideas reach fruition.

Holywood, Co. Down. F. H. ROBERTSON.

A Famous Balloonist

IN the very charming little parish Church of St. Peter, East Blatchington, Seaford, Sussex, is a commemorative plaque:—

"This tablet is placed here to the memory of
The Famous Aeronaut
HENRY TRACEY COXWELL
for many years a resident of this Parish
Died Jan. 5 1900. Aged 81 years.
Of the many remarkable balloon ascents made by him for scientific purposes during his long career the most notable was from Wolverhampton, September 1862 when he reached an altitude of seven miles the greatest height ever attained by man.
Erected by his widow."

It would be interesting to know more about this pioneer.

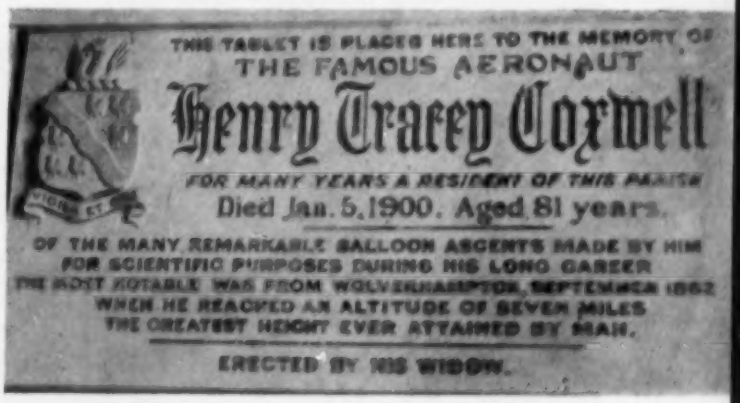
London, E.C.4. JAMES LAWRIE.

[We have a photograph of this particular memorial, and it is reproduced below. Coxwell (1819-1900) made numerous scientific-research ascents with James Glaisher, F.R.S., first hon. treasurer of the Aeronautical Society. In their 1862 ascent from Wolverhampton, a height of about 37,000ft was probably reached, though both aeronauts temporarily lost consciousness owing to lack of oxygen after making their last observation at 29,000ft.—Ed.]

IN BRIEF

We learn that A. Cdre. A. H. Wheeler is still anxious to find a Wolseley Viper engine for the S.E.5A, which is waiting, powerless, in the Shuttleworth Collection of historic aircraft.

The memorial tablet referred to above by Mr. James Lawrie.


THIS TABLET IS PLACED HERE TO THE MEMORY OF
THE FAMOUS AERONAUT
Henry Tracey Coxwell
FOR MANY YEARS A RESIDENT OF THIS PARISH
Died Jan. 5, 1900. Aged 81 years.
OF THE MANY REMARKABLE BALLOON ASCENTS MADE BY HIM
FOR SCIENTIFIC PURPOSES DURING HIS LONG CAREER
THE MOST NOTABLE WAS FROM WOLVERHAMPTON, SEPTEMBER 1862
WHEN HE REACHED AN ALTITUDE OF SEVEN MILES
THE GREATEST HEIGHT EVER ATTAINED BY MAN.
ERECTED BY HIS WIDOW.

THE INDUSTRY

Hunting Percival Apprentice Prizegiving

THE chairman of the Hunting Group, Mr. P. Ll. Hunting, recently presented the annual awards to Hunting Percival apprentices at Luton. During his address he commented that there were four times as many prizewinners as when he presented the awards three years ago. His advice to apprentices was that they should learn to be adaptable, not only cultivating interests other than the purely engineering, but taking an interest in the work and problems of their colleagues in the activity opposite their own, be it design or production.

The apprentice supervisor, Mr. H. G. Hammond, said in his annual report that apprentices had shown outstanding improvement in technical studies. The failure-rate in examinations had dropped to 30 per cent and he believed this figure would be bettered if the City and Guilds courses in aeronautical engineering practice were revised so that they were related less to the craft of fitter/turner. There were now 118 apprentices in training. Principal prizewinners were:—

Best All-round Apprentice, Higher National Certificate with Distinction in Structures, awarded Hunting Aviation Scholarship.—D. J. McNally (now at College of Aeronautics). *Best Technical Apprentice*, G.C.E. (A) Mathematics and Physics, gained university admission.—D. C. Conroy (now at University of Southampton). *Best Practical Apprentice*, City and Guilds Final Certificate.—K. M. Poulter (now in R.A.F.). *Lawes Rabjohns Prize for Draughtsmanship.*—J. Wathew.

Chief Draughtsman at Shoreham

THE appointment of Mr. P. T. Moriss-Jeffery as chief draughtsman has been announced by F. G. Miles, Ltd. Mr. Moriss-Jeffery has spent some 20 years in engineering, mainly in the aircraft industry. He first joined Westland Aircraft, working on the Pterodactyl under Prof. Hill, and then moved in 1936 to duties under Mr. F. G. Miles at Phillips and Powis Aircraft, Ltd., engaged on many Miles aircraft including the M.52 supersonic project. He left in 1947, after which he was successively with Saunders-Roe, Chrislea, Westland Aircraft and de Havilland. In his new post, Mr. Moriss-Jeffery will take charge of the drawing office, working on the M.100 Student primary jet trainer, and Miles/Hurel Dubois high-aspect-ratio developments.

Mr. P. T. Moriss-Jeffery.

Dowty Apprentices Rewarded

SPEAKING at the recent annual prize giving to apprentices of Dowty Equipment, Ltd., at Arle Court, Cheltenham, Sir Godfrey Ince (Permanent Secretary, Ministry of Labour and National Service), said that automation was likely to require more skilled men for maintenance work, and more skilled men for the production of automatic control equipment. He saw no reason why this country, with its inventive genius and its craftsmen, should not become the leading producer of such equipment. Later in his address Sir Godfrey said that at Dowty's young men were being trained as skilled craftsmen by experts in one of the best-equipped and most efficient training schools in the country.

In welcoming Sir Godfrey, Mr. George Dowty mentioned the help given in apprentice-training by Mr. A. W. Hildrew, Principal of North Gloucestershire Technical College.

Prizes

First-Year Apprentices, C. Snell, W. Popiel; 2nd year, M. Crouch, M. Evans; 3rd year, D. Parker, C. D. Williams; 4th year, R. B. Shayler, D. Morgan; 5th year, J. Child, I. R. Hughes.

Plant Department Progress Prize, J. Savory; *Production Engineering Apprentice Prize*, B. T. Smith; *Coventry Precision Ltd. Prize.*—Senior, M. Perkins; Junior, P. Sanderson; *New Mendip Engineering Prize.*—Senior, R. Evans, Junior, R. Styles; *Commercial Training Prize*, B. Harries.

Completed Indentures

Dowty Equipment Ltd.: R. G. Brown, I. J. Camm, R. J. Canning, V. K. Carter, J. W. Child, E. P. Gardiner, D. Hall, R. P. Hodges, I. R. Hughes, P. Leach, D. G. Llewellyn, T. Lush, J. A. Moore, J. R. Palmer, E. D. Simons, B. T. Smith, R. S. Walters, A. Woodward. *Dowty Nucleonics:* D. Stewart. *New Mendip Engineering:* M. Tae, M. Pidden, W. Hutchison, K. P. Mullet, G. A. Peaple, D. Ludlow.

Mr. P. Ll. Hunting, chairman of the Hunting Group, speaking at the Hunting Percival apprentice prizegiving (see first news item).

Cossor A.C.R. Orders

ORDERS for Cossor Mk VI airfield control radar are stated by the company to exceed £1m in value. Five are operational, including three overseas installations—the one at Zurich, and two military versions for the Royal Netherlands Air Force—and twelve are still in process of manufacture for various customers, who include the Ministry of Transport and Civil Aviation and the Ministry of Supply. A number of major airports are to be equipped, and already the installation at London Airport with its 14ft-diameter dish aerial is a distinctive landmark.

The Mk. VI—an S-band (10 cm) surveillance radar—is used for short- and medium-range cover of an airfield and its approaches. It can be operated independently of any other radar, or in conjunction with precision approach radar to form a complete C.C.A. system.

IN BRIEF

Hale Hamilton, Ltd., of Frays Mill Works, Cowley Road, Uxbridge, have recently been given full A.I.D. approval for their precision valves.

* * *

Plant for the production of some 130,000 tons of aviation gasoline a year is to be installed at B.P.'s refinery on the Isle of Grain. The plant, which will cost about £6½m, is expected to be in operation by 1958.

* * *

Sir George Godfrey and Partners, Ltd., have negotiated with Svenska Rotor Maskiner of Stockholm an exclusive licence to manufacture the S.R.M. high-speed rotary screw-type compressor and expander for aircraft use. This arrangement will extend the company's existing range of cabin superchargers and cooling units and make available small lightweight compressors stated to be ideally suitable for vapour-cycle cooling systems.

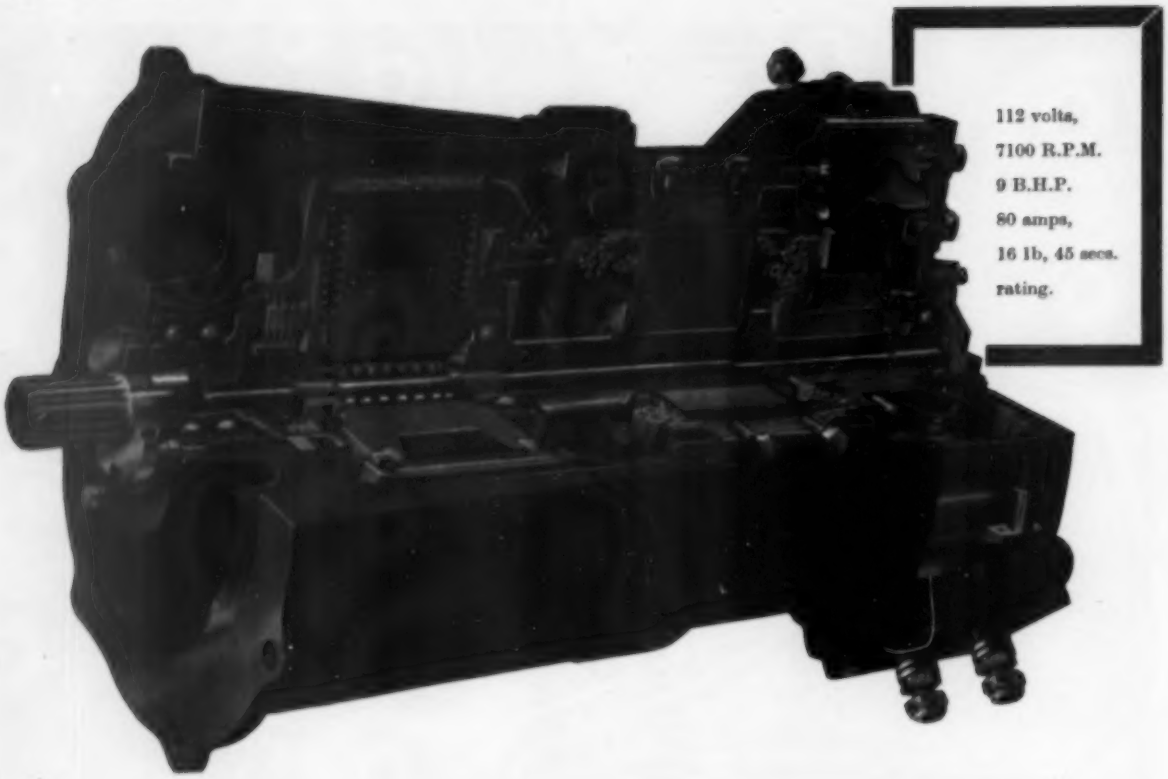
* * *

G/C. R. C. M. Collard, sales manager of Handley Page, Ltd., is now on a three weeks' tour of the Middle East, enlarging the company's representation in that area and visiting potential purchasers of the Herald. G/C. Collard's itinerary includes Turkey, the Lebanon, Syria, Iraq, Jordan, Egypt and possibly Kuwait.

* * *

The wooden skis fitted to the Auster Mk 74 aircraft accompanying the Trans-Antarctic Expedition led by Dr. V. E. Fuchs and Sir Edmund Hillary are surfaced with Bakelite laminated fabric sheet, grade F.10810. Strong and light in weight, this material provides the skis with the resistance to abrasion necessary for operation from surfaces where snow, ice and rock frequently combine to provide extremely rough conditions.

TGA AT403



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This fine study of a B.E.A. Whirlwind was secured last week while noise-level measurements were being taken. The possibility of using a floating platform on the Thames as an air station is now being investigated.

CIVIL AVIATION

B.I.A.T.A.'s "FRUSTRATION" REPORT

AT the annual meeting of the British Independent Air Transport Association, held in London last Monday, Mr. M. H. Curtis handed on the chairmanship of the association to Sir Archibald P. Hope, joint managing director of Airwork, Ltd.

Mr. Curtis, the managing director of Hunting-Clan Air Transport, Ltd., presented what he called a "frustration" report on B.I.A.T.A. members' activities during the past year. "By 1955," he said, "the independent operators should have been bringing modern aircraft into operation; procurement plans should have been made for years ahead; commercially sound operations should have been under way which held out clear long-term prospects of future progress." Instead, few aircraft were on order, the independents were mainly confined to "insecure and economically doubtful operations," and they were finding increasing difficulty in assessing where their future prospects—if any—lay.

The large orders now being placed in other countries for new equipment emphasized that not a day should be lost in making decisions on future procurement. "A day lost," Mr. Curtis continued, "can mean years of advantage handed to competitors. Prolonged delay in ordering new equipment could mean eventual extinction of the independent concerns except for a few 'fringe' operations."

Mr. Curtis pointed out that trooping today represented 67 per cent of total passenger-miles operated by the independent airlines; but such work, he contended, was too uncertain and short-term to be of value towards long-term development.

The report shows that at the end of the period covered by the report (the year ended June 30th, 1955), the 21 members of the association were operating a total fleet of 227 aircraft, comprising 71 four-engined, 135 twin-engined and 21 single-engined machines. Aircraft on order totalled 19—seven Viscounts, three DC-6As, six Heralds and three Bristol Freighters. Even those orders, the report says, are by no means justified in the face of the limited commercial opportunities open to the independents, but they have been placed in the belief that future traffic expansion will demand increasing independent participation.

NEW JET CUSTOMERS?

SABENA, the Belgian airline, are reported to have an option, expiring on December 1st next year, on three Boeing 707s. Powered by P. and W. J75s; the aircraft would be delivered in 1960. Another report says that Japan Air Lines have made financial provision for an order for Douglas DC-8s.

VISCOUNTS FOR NEW ZEALAND

ORDERS for three Vickers Viscount 800s have been approved by the New Zealand Government at a total cost of £1,500,000. Announcing this in Wellington on November 29th, Mr. Thomas Shand, Civil Aviation Minister, said that the Viscounts would operate on the main Auckland-Christchurch-Wellington route after delivery in 1957-1958.

FRIENDSHIP IN THE AIR

THE first prototype Fokker F.27 Friendship made its maiden flight at Schiphol on November 24th. The flight lasted 34 minutes and was described as "very successful." At the controls was Mr. H. V. B. Burgerhout, an accomplished though not a full-time pilot (he is a member of Fokker's foreign sales department, and was responsible for much of the market research on which the Friendship specification was based). Powered by two Rolls-Royce Darts, the Friendship is a 28/36-seater designed for stages of about 300 miles.

TYNES AND ELANDS FOR LOCKHEED

THE Lockheed Aircraft Corporation are reported to have ordered two Rolls-Royce Tynes and two Napier Elands for delivery as soon as possible. Required, presumably, for evaluation as potential powerplants for the Electra, the turboprops will be installed in "Old 1961," the famous Constellation prototype which has been used in a variety of experimental rôles, including engine testing.

SIR MILES'S APPOINTMENT

SIX questions about the recent appointment of Sir Miles Thomas as a part-time director of a motor firm were asked in the House of Commons on November 22nd. The Minister of Transport and Civil Aviation, Mr. Boyd-Carpenter, said in reply that he was satisfied that the small amount of additional work involved would not in any way affect Sir Miles's discharge of his duties as chairman of B.O.A.C. It was often valuable for the head of one great industry to have direct, inside contact with others.

MORE C.P.A.L. POLAR SERVICES

CANADIAN PACIFIC intend to increase their trans-polar service between Canada and Australia *via* Amsterdam to a twice-weekly operation next April. Four more DC-6Bs are on order. A third service, to Amsterdam only, will start in the summer.

S-58s IN DEMAND

NEWS that Sabena are to purchase eight Sikorsky S-58s, thus increasing their helicopter fleet to 14, is a reminder of the success of the company's helicopter activities. During the first two years of operation Sabena's six 7-passenger S-55s carried 50,000 passengers on a route network linking Brussels with Bonn, Cologne, Duisburg, Lille, Rotterdam, Maastricht and Eindhoven. The 12-passenger S-58s, due for delivery in the spring of next year, will permit a big expansion of operations; it is estimated that 70,000 passengers will be carried next year alone.

Another commercial S-58 order comes from Okanagan, the Canadian company who, with a fleet of six S-55s and 20 Bell helicopters, are

The Sabena executives seen appraising a model of the 12-seat Sikorsky S-58 are (left to right) M. A. Vernieuwe, executive vice-president; M. G. Claeys, managing director; M. W. Desworte, general manager; and M. G. Perier, chairman. Sabena's order for eight 'S8s is reported above.

A Hermes IV of Skyways gets away smartly from Changi, Singapore. Taking-off at 83,000 lb, the aircraft was operating at 3,000 lb below the maximum; the intersection shown is some two-thirds of the way down the 6,000ft runway.

CIVIL AVIATION . . .

the world's largest rotary-wing operators. Based at Vancouver, Okanagan specialize in nation-wide operations on behalf of industrial firms. Okanagan have ordered one S-58 initially for crew training. The company's president, Glen W. McPherson, in announcing the order said: "The purchase of this aircraft is the beginning of a new expansion programme. More of the big Sikorskys will soon be on order."

CIVIL AIRCRAFT EXPENDITURE

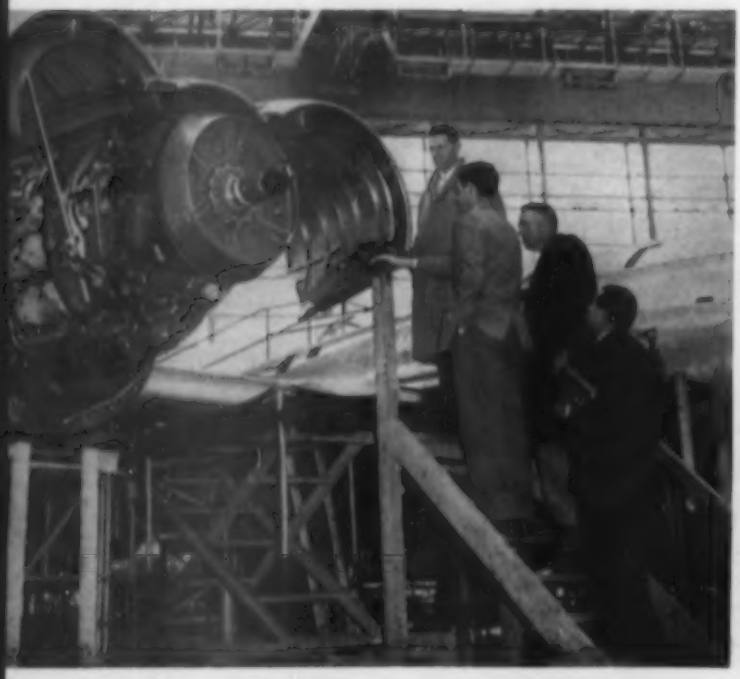
AS reported briefly in *Flight* last week, the Minister of Supply recently listed the sums of money spent by his Department since the war on certain types of aircraft. Given in the form of a written reply, the information released by the Minister is tabulated in full below:—

Aircraft Type	Cost* (£x1m)	No. ordered Pre-totypes	No. ordered Produc-tion	Date ordered	No. ordered Pre-totypes	No. ordered Produc-tion	No. now† flying
Shetland ...	1	2	10	1941	1	0	0
Apollo ...	1.35	2	0	1946	2	0	1
Brabazon ...	4.5	2	0	1945	1	0	0
Sandringham	0.12	4	15	1945	1	15	1
Solent ...	0.1	0	18	1946	0	18	8
Tudor ...	0.65	4	101	1944-48	4	35	10
Hermes ...	1.3	4	25	1944-47	2	25	17
Air Horse ...	0.38	2	0	1947	2	0	0
V.1000 ...	2.3	1	6	1953-54	0	0	0
Princess ...	8.0	3	0	1946	1	0	1
Comet 1 ...	4.25§	2	19	1947-52	2	9	0
Comet 2 ...		2	37		1	0	1
Comet 3 ...		1	18		0	0	1

* Figures quoted refer to "net development expenditure, cost of prototypes, etc."

† "Number of aircraft still capable of flying, i.e., holding current certificates of airworthiness." The Apollo, five Tudor 9s (Ashtons) and one Hermes included in this column are flying under Service control, and do not hold Cs. of A.

§ Expenditure to date.



U.S. JET CERTIFICATION PROGRAMME

BOTH Boeing and Douglas have applied for type certificates for their new jet transports, states a C.A.A. announcement. A similar request is expected shortly for the Lockheed Electra. The first step towards certification of an American turbine-powered aircraft will be taken this month when the Administration convenes a "type board meeting" on the Boeing 707. Mr. F. B. Lee, Administrator of Civil Aeronautics, has endorsed the manufacturers' statements that construction and testing of the new aircraft will take approximately three years.

K.L.M. AND AIR CEYLON

THE terms of the recently concluded agreement between K.L.M., the Air Ceylon Corporation and the Government of Ceylon are outlined in an announcement from the Dutch airline. K.L.M. are stated to have acquired a financial interest in Air Ceylon "for an initial period of ten years." Control of Air Ceylon, however, remains in Ceylonese hands.

Using Constellations manned by K.L.M. crews, Air Ceylon will resume international operations in February 1956 with a weekly return service between Colombo and London. Meanwhile, Ceylonese crews will be trained by K.L.M. "Plans have been laid," it is stated, "for the future development of Air Ceylon services and for the purchase of modern aircraft."

BREVITIES

IT was announced in Montreal last week that T.C.A. are considering the purchase of nine more Viscounts. No definite decision has been made but the airline has asked Vickers how soon an order would have to be placed for delivery in 1958. Of 25 Viscounts ordered by T.C.A., 14 have been delivered and four are due for delivery next spring; the remaining seven will follow in March 1958.

* * *

Regular air services between Belgrade and Moscow, operating four times weekly, were expected to begin on November 29th. Flights operate via Budapest, but it is not known whether the service provides through travel in one aircraft or whether passengers must transfer from J.A.T. to Aeroflot at Budapest.

* * *

Formation of a German air charter company was announced last week by Lufthansa. The new company will have its head office at Frankfurt. The majority of the share capital of £250,000 will be held by two leading German shipping lines—Norddeutsche Lloyd of Bremen and HAPAG of Hamburg—with Lufthansa and the German State railways holding the remainder.

* * *

Tests with plastic covers for I.L.S. localizer antennae are being conducted by the C.A.A. Technical Development and Evaluation Centre at Indianapolis. The localizer, which gives azimuth information to pilots making instrument approaches, is normally covered by a wooden structure.

* * *

Some 20 Thames-side sites have been surveyed recently with a view to finding a new London helicopter station; none of these sites, however, is regarded as "altogether satisfactory" by the M.T.C.A. In collaboration with B.E.A., the Port of London Authority and the L.C.C., the Ministry is considering the possibility of using a floating platform in the Thames. Preliminary trials have been carried out at Southampton Water on a 100ft by 48ft platform lent by the Royal Navy, and six platform sites on the Thames have been surveyed.

Despite their recent purchase of six DC-8s, National Airlines retain a keen interest in the Britannia, as indicated by a recent visit to Filton by two of the Miami company's executives. Shown inspecting a Proteus 705 installation are (left to right), Mr. H. K. Pike, National; Mr. D. S. Stewart, Britannia development manager; Mr. C. H. Ruby, National; and Mr. T. Hoyle, of Bristol's aircraft sales department.

Beaver on location: In "the largest scene ever brought to the screen," 12,000 natives trample down 20ft kunai grass to make a landing strip in New Guinea. The sequence is from a new Australian film "Walk Into Paradise," starring Chips Rafferty, Reginald Sye, Francoise Christophe, and Pierre Cressoy. Is this the first time a Beaver has needed a 24,000-foot runway?

FROM THE CLUBS

PRESENTING the chairman's report at the first annual meeting of the Aeroplane Owners' and Pilots' Association of South Africa, Dr. J. N. Haldeman reviewed the activities of the organization since its formation. In the short time the Association had been operating, he said, much had been accomplished. The Association had contributed towards bringing the Air Navigation Committee to life again, and the air navigation regulations were being completely rewritten. Opposition had been organized to a Notam "which would have killed light-plane flying completely by cutting the country up into so many prescribed areas and restrictions that it would have been useless for light-plane fliers to continue flying". An agreement had been secured to revise these controlled areas in order to allow free air-space for light aircraft.

The Association had recently secured the discontinuation of compulsory modifications on aircraft which were not required in the United States but which were being imposed in the Union. "The requirement for an axe and a fire-extinguisher in the cockpit, which was generally considered a hazard and a nuisance in light aircraft, will no longer be required. The natives in the Union were the chief beneficiaries of the axe requirement and should be well supplied now." The A.O.P.A. of S.A. was continuing to co-operate fully with the Division of Civil Aviation which, in turn, was consulting the Association. During its first year, the Association had obtained many concessions to improve flying in the Union and was on the way to obtaining more. In conclusion, Dr. Haldeman said that he was convinced that there was a practical home demand for 10,000 aircraft in the Union. This could form a basis for a large aircraft industry which would make a major contribution to the country's economy and defence.

A VISITOR to *Flight's* offices recently was Mr. T. A. L. Concannon, who brought news of the Kuala Lumpur Flying Club. Mr. Concannon is a member of the club and until recently, when he came back to England on leave, was its vice-president. At present, as a result of accidents, the club's fleet is down to two aircraft—a Tiger Moth and an Auster. Plans are being made for the purchase of new aircraft, but the type has yet to be chosen.

Despite some easing of the Malayan emergency, it is still necessary in many areas to make "pay drops" to tin mines and rubber estates in order to avoid possible ambush by terrorists; the K.L. Flying Club is continuing to play a full part in this work, together with the Penang, Perak and Royal Singapore Flying Clubs.

October 1st saw the formal reopening of the Kuala Lumpur clubhouse, which has been re-designed and newly furnished. This was an event of more than club interest, because in the absence of a proper terminal the building has come to be known as the social centre of Kuala Lumpur airport.

Membership of the club now stands at about 400, including some 40 licensed pilots. Chinese and Indian members are among the pilots, and two Malayan students are under instruction. Following the appointment of S/L. A. E. Nichol as a Beaver pilot with the Federation Air Service, the club is temporarily without a C.F.I. The breach has been filled, however, by honorary instructors, including Service pilots from R.A.F. Kuala Lumpur.

FORTHCOMING EVENTS

Dec. 2. Aircraft Golfing Society: Dinner and Dance.
Dec. 5. British Interplanetary Society: "Probing Interplanetary Space," by E. Burgess, F.R.A.S.
Dec. 6. Society of Instrument Technology: "Planning a Servo-mechanisms Laboratory for Instructional Purposes," by E. M. Pearson, M.Sc., A.M.I.E.E., A.F.R.Ae.S.
Dec. 6. R.Ae.S.: Section Lecture: "Fatigue Aspects of Structural Design," by W. A. P. Fisher, B.A., A.M.I.Mech.E.
Dec. 9. Helicopter Association: "Helicopter Turbine Installations," by A. W. Morley, Ph.D., M.Sc., A.C.G.I., A.F.R.Ae.S.
Dec. 10. British Interplanetary Society: "Pilotage and Navigation of Interplanetary Vehicles," by P. H. Tanner, B.Sc.
Dec. 14. R.Ae.S.: Graduates and Students Section: "The Domain of the Helicopter," by R. Hafner, F.R.Ae.S.
Dec. 14. British Institution of Radio Engineers: "Remote Presentation of Radar Information," by G. J. Dixon and H. H. Thomas.
Dec. 16. London Airport Inauguration by H.M. the Queen.
Dec. 16. R.Ae.S.: Section Lecture: "Airships of Today," by Lord Ventry.
Dec. 20. R.Ae.S.: Section Lecture: "Recent Advances in Aircraft Adhesives," by Dr. H. A. de Bruyne, M.A., F.R.Ae.S.

R.Ae.S. Branch Fixtures to December 14th:—

Dec. 2, *Chester*, Annual Dance. Dec. 5, *Halton*, "Parachutes," by W. D. Brown. Dec. 7, *Bristol*, "A New Approach to Aircraft Design for Production," by W. E. W. Petter; *Brough*, "Aerial Photography," by Charles E. Brown; *Chester*, "The Pioneer," by N. J. Capper; *Reading and District*, "Airframe Fatigue," by W. Tye. Dec. 8, *Isle of Wight*, Annual General Meeting and Film Show. Dec. 9, *Glasgow*, "Test Flying," by Ben Gunn. Dec. 12, *Halton*, Film. Dec. 13, *Belfast*, Brains Trust. Dec. 14, *Coventry*, Film; *Manchester*, "NATO Air Power and the Preservation of Peace," by Air Marshal Sir Robert Saundby.

Among the finest fighters now in service anywhere in the world are the Canadair Sabre Mk 6s with the latest Orenda 14 engine. This formation was flown by pilots of the R.C.A.F.'s No. 1 Overseas Ferry Flight.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

Visit of the French C.A.S.

EARLIER this week, Gen. Paul Bailly, Chief of the Air Staff of the French Air Force, paid an official visit to the R.A.F. He arrived on Monday at Northolt, where he was greeted by Marshal of the R.A.F. Sir William Dickson, and afterwards called on the Minister of Defence and the Under-Secretary of State for Air. General Bailly later visited the Central Fighter Establishment, West Raynham, H.Q. Fighter Command, Stanmore, and H.Q. Bomber Command, High Wycombe. He was welcomed at Fighter Command by the A.O.C.-in-C., Air Marshal Sir Dermot Boyle, and at Bomber Command by the Acting A.O.C.-in-C., A.V-M. S. O. Bufton.

Radio-active Samples

AFTER the Russians had exploded their nuclear device recently, R.A.F. aircraft climbed to 50,000ft over Britain and brought back samples of the upper air. These were found to be radio-active and some deductions about the nature of the Russian explosion were made from them by scientists at Harwell and Aldermaston.

Australian Rescuers Honoured

SEVERAL awards for outstanding services during the serious floods in New South Wales last February and March have been announced in the *London Gazette*. A helicopter pilot, Lt-Cdr. D. F. Farquharson, R.N., is appointed O.B.E. (military version) for his work in command of a R.A.N. helicopter flight which immediately went into action. He was personally responsible for the rescue of 36 people. A similar award has been made to Lt-Cdr. G. McPhee, R.A.N., who piloted the first helicopter to be despatched on life-saving operations. At one stage his own aircraft crashed and he continued to fly rescue sorties and was personally responsible for the rescue of nine people.

Also made O.B.E. is S/L. R. S. Garvin, who was stationed at Dubbo, New South Wales, at the time. He co-ordinated and led rescue operations in his area and rescued some 300 citizens from danger. W/C. McCormack was awarded the A.F.C. for his work in flying an Anson on reconnaissance and supply missions in the Maitland-Singleton areas. He flew in very bad weather and found many families to whom he directed helicopters. F/L. R. J. McKimm was also awarded the A.F.C. for his rescue, with a helicopter, of five people in imminent danger of drowning. His winch failed and three of the five people had to be enabled to climb directly into the helicopter as it hovered between trees and high-tension cables with its wheels practically in the water. He flew 76 hr on flood relief.

L.A/C. M. J. Seton was awarded the A.F.M. for his work as a volunteer spotter and winch-operator in a R.A.N. helicopter. He is the first non-flying airman in the R.A.A.F. to be awarded a flying decoration. L.A/C. R. N. Chapman and L.A/C. R. J. Stoddard were both awarded the B.E.M. Chapman rescued a woman who had come into contact with a high-tension cable buried in the mud and, though suffering from shock, continued to work for a further day. L.A/C. Stoddard was one of the first to volunteer for rescue work and after local rescue operations had ceased, he continued to assist in supply-dropping

More Arctic Jet Flights

A FURTHER series of high-latitude navigation training flights, led by A. Cdre. G. A. Walker, Commandant of the R.A.F. Flying College, are to be made in a Canberra from Bodö, Norway, between December 12th and 14th. A. Cdre. Walker will fly the Canberra to Bodö on December 12th and captain the aircraft on the first of the northern flights with S/L. R. S. Sanders and F/L. A. S. T. Harris as navigators. The Canberra will be airborne for 5½ hr, passing over Spitzbergen on a direct out-and-return flight into the Arctic.

W/C. I. G. Broom, who piloted the Canberra *Aries IV* on its record transatlantic flight last June, will fly the second sortie. His navigators will be S/L. R. G. Price and S/L. R. A. Seymour (who is a college navigation specialist and who flew in *Aries IV* across the Pole and the Atlantic last June). Reserve pilot and navigator for these flights will be respectively W/C. W. Hoy and F/L. K. H. Hoxey. The second crew and the reserves, together with six ground crew, will fly to Bodö in a Valetta on December 11th. The object of the flights, each of which will cover about 2,400 miles, is to give high-latitude navigational experience to Flying College staff and students.

Jet Provost Progress

EIGHTEEN cadets have now spent over two months on the first Jet Provost training course at Hullavington, Wilts. Of the eighteen—none of whom was specially picked for the course—all have gone solo. Only six had any previous flying experience.

The course started on September 21st and on October 17th the first pupil without previous experience made a successful first solo after 8 hr 20 min flying. The remainder all soloed by the end of that month. For those with previous experience the average time to first solo on Jet Provost was 9 hr 15 min and for those without previous experience it was 11 hr 15 min. The average for the whole course was 10 hr 35 min.

Most of the flying was carried out from Keevil, a satellite of Hullavington, and all landings and take-offs were made from runways, thus bringing the additional problems of cross-winds in the early instructional stage. The nose-wheel undercarriage of the Jet Provost is reported to have minimised difficulty in this respect.

S. of S.'s Tour

CONTINUING his tour of R.A.F. units in the Far East, Lord de Lisle and Dudley, V.C., Secretary of State for Air, reached Kuala Lumpur last week and flew by helicopter to visit many of the forts deep in the Malayan jungle. On Monday he returned to Singapore. His next port of call is Ceylon.

R.A.F. for Atomic Tests

A GREATER contingent of R.A.F. personnel than before is to assist in the third series of British atomic weapons tests scheduled to take place in the Monte Bello Islands next April. The R.A.F. will further play a prominent part in the fourth series of tests which will be made late next year at the new test ground now being prepared at Maralinga in the Central Australian Desert. Helicopters and a Valiant are likely to be used in next April's tests.

Famous Lancaster Preserved

LANCASTER No. R.5868, stored at a maintenance unit since World War 2, has now been sent to join the other historic aircraft which were previously housed at Stanmore Park, Middlesex, and which, in the Air Ministry's words, "have now been moved to facilitate preservation and maintenance." The Lancaster flew 137 sorties over enemy territory, first with No. 83 Sqn. and then with No. 467 Sqn., R.A.A.F. It still bears the 137 bomb silhouettes applied by ground crews during the war and the emblems of a D.S.O. and three D.F.C.s won by air crews who flew it. Beneath these are inscribed the words "No enemy planes will fly over Reich territory—Hermann Goering."

R.5868, which is believed to have flown more operational sorties than any other aircraft in Bomber Command, survived many attacks by German night fighters, was once hit by tail-turret fire from a friendly bomber and managed to return home after colliding with another Lancaster in the bomber stream.

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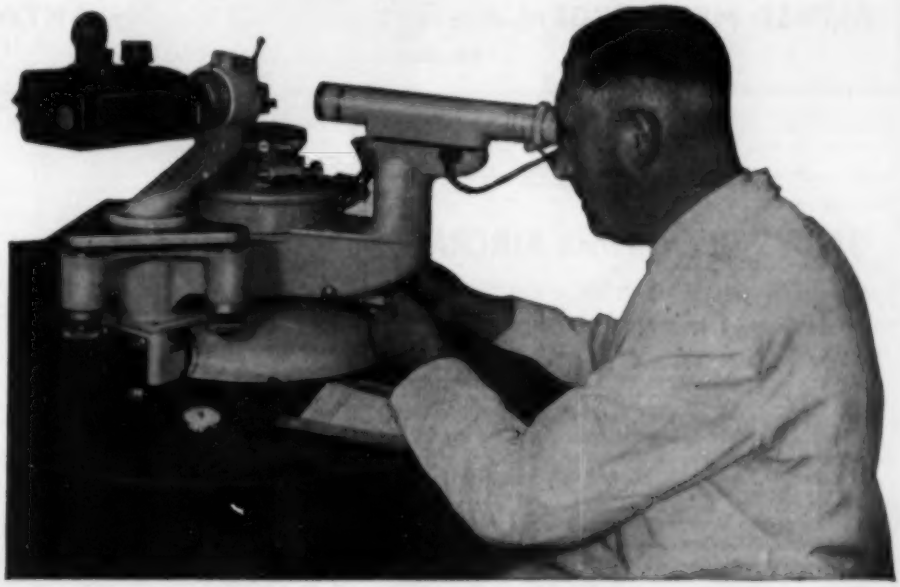

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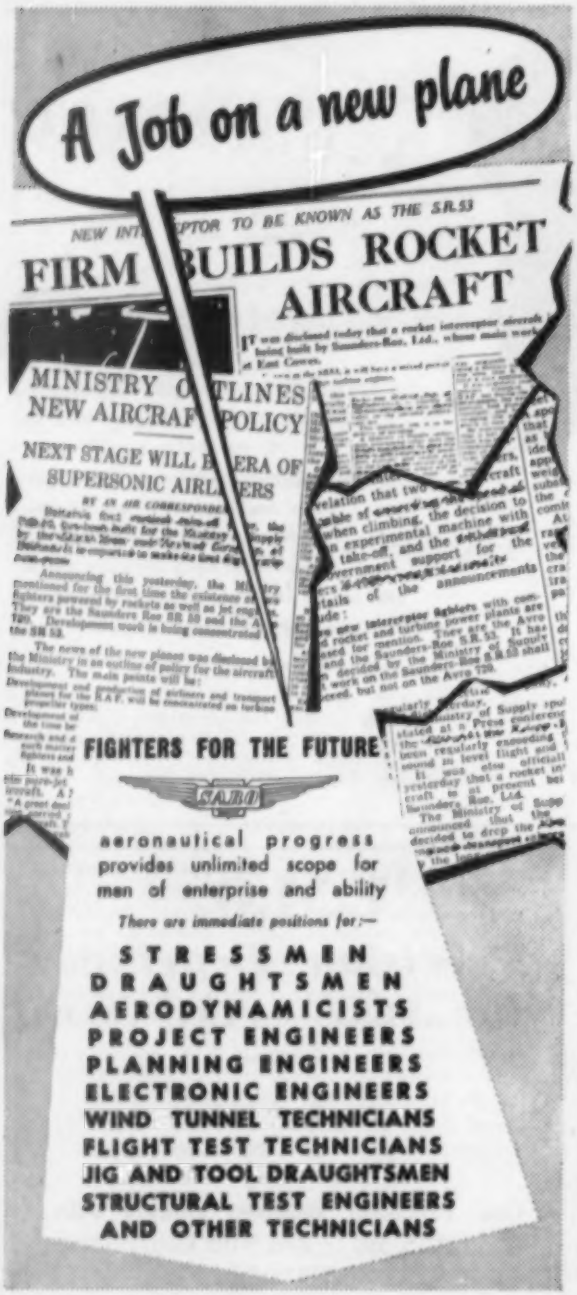

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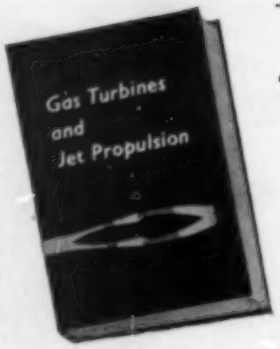

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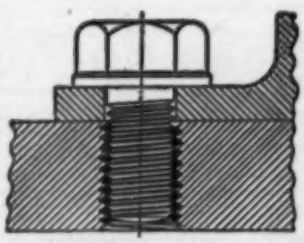

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PATENTS

NOTICE is hereby given that J. C. M. Frost and A. V. Roe Canada Limited seek leave to amend the Complete Specification of the Application for Letters Patent No. 734,674 for an invention entitled "Cellular fuel tank." Particulars of the proposed amendments were set forth in the Official Journal (Patents), No. 3484 dated 23rd November, 1955. Any person may give Notice of Opposition to the amendment by leaving Patents Form No. 36 at the Patent Office, 25 Southampton Buildings, London, W.C.2, on or before 23rd December, 1955. [4556

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PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:

APPLICATION No. 686. From Cambrian Airways, Ltd., of Cardiff (Rhoose) Airport, Near Barry, Glamorganshire, for a U.K. Internal Service to be operated with Dakota, D.H. Dove and D.H. Heron aircraft for the carriage of passengers, supplementary freight and mail between Bristol (Whitchurch), Cardiff (Rhoose) and Belfast (Nutts Corner) at an initial frequency of three return flights weekly increasing in accordance with demand for a period of 10 years, commencing 1st May, 1956.

APPLICATION No. 687. From Skyways, Ltd., of 7 Berkeley Street, London, W.1, for a Seasonal Inclusive Tour Service to be operated with Hermes aircraft in conjunction with Travel Planning, Ltd., for the carriage of passengers and supplementary freight between London (Blackbushe or Stansted) and Venice (Treviso) at a frequency of from one to two return flights weekly, to be operated on Saturdays and Sundays during the season from April to September inclusive each year for a period of seven years, commencing April, 1956.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Deans' Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections.

The Air Transport Advisory Council also give notice that the following applications from Eagle Aviation, Ltd., of 29 Clarges Street, London, W.1, for Normal Scheduled Services have now been withdrawn:

APPLICATION No. 457. For a service between Manchester (Ringway), Lille (Lesquin), Munich Riem), Graz (Thalerhof) (optional service stop) and Belgrade (Zemun).

APPLICATION No. 458. For a service between Birmingham (Elmdon), Lille (Lesquin) Munich (Reim), Graz (Thalerhof) (optional traffic stop) and Belgrade (Zemun).

THESE applications were advertised in "The Times", "The Aeroplane" and "Flight" on Friday, 11th February, 1955. [4549

PUBLIC APPOINTMENTS

MINISTRY OF SUPPLY National Gas Turbine Establishment near Farnborough, Hants, requires Experimental Officers and Assistant Experimental Officers. Duties: problems of combustion, heat transfer, aerodynamics, projects and performance instrumentation, and application of electronics in gas turbine research. Qualifications: H.S.C. (Science) or equivalent but possession of a degree or H.N.C. in an appropriate subject may be an advantage. Houses may become available for successful candidates, if married. Salary within E.O. range (min. age 26)—£756-£920. A.E.O.—£306 10s. (age 18)-£670. Equal pay scheme. Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C854/5A/All. Closing date December 17th, 1955. [4532

MATHEMATICIAN required by Ministry of Supply at R.A.E., Farnborough, to assist senior officer engaged on studies in fundamental theoretical fluid motion. Duties involve high grade computing, including final development of equations to functions and integrals with known solutions and subsequent numerical evaluation, and production of schemes for numerical computation using automatic machinery, etc. Quals.: H.S.C. (Science) or equivalent, but should preferably possess mathematical knowledge equivalent to pass degree. Appointment initially as Asst. Expl. Officer within range £403 10s. (age 21) to £670. Equal pay scheme. Application forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 417/5A/BII. Closing date December 17th, 1955. [4541

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CANDIDATES must be between 21 and 28 during 1955 (up to 31 for permanent members of the Experimental Officer class). They must have a First or Second Class Honours degree preferably in physics or mathematics. Salary scale (men in London) £513-£925, somewhat lower in provinces. Women's salaries lower but being improved under equal pay scheme. Promotion prospects to Senior Scientific Officer (£1,070-£1,245), and higher posts.

APPLICATION forms from Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. 552/55. (Met.). Latest date for receipt of completed forms December 31st, 1955. [4540

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FORMS of tender, which are returnable on Friday, 6th January, 1956, may be obtained from this Office, (C.D.N. Branch), upon payment of a fee of 10s., which is not returnable. Tenders from A.I.D. approved firms only, will be acceptable.

REFERINCE No. 5196/55(C.D.N.) must be quoted in all applications. [4560

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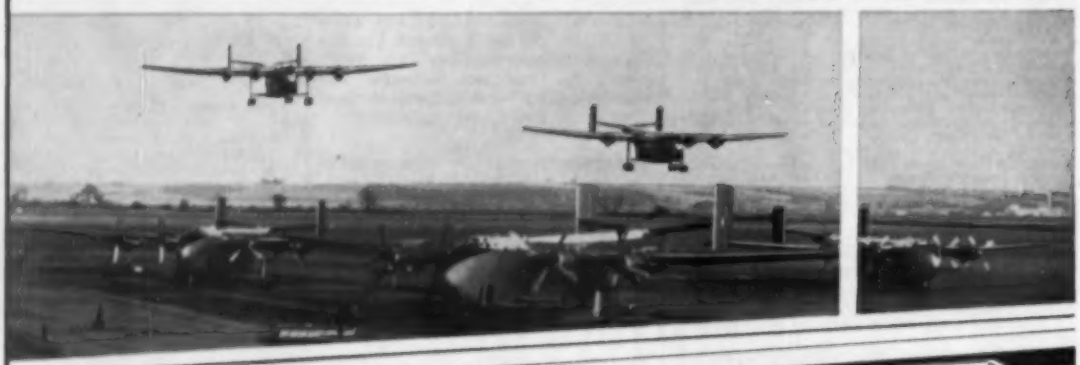

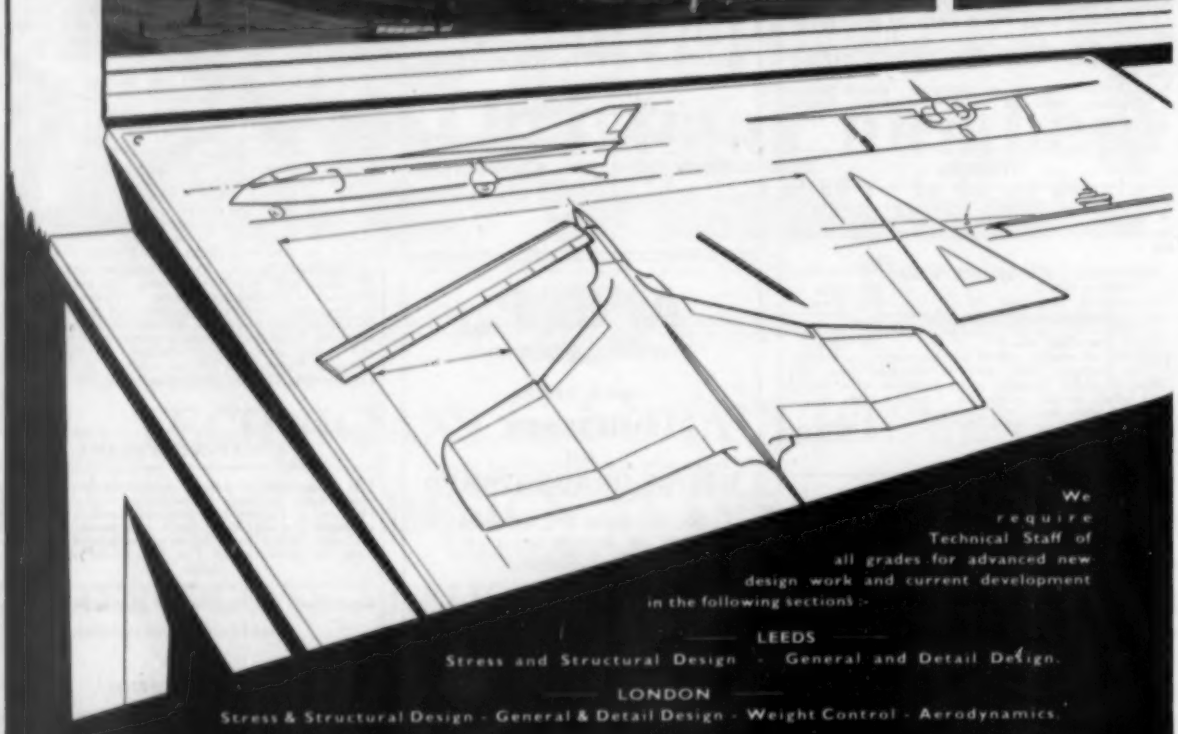

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